Number 6

The Welding Engineer

Reg. U. S. Pat. Office

oneer Business and Technical Journal of the Welding Industry

THE "SKY-RIDE"—*The Big Thrill of A Century of Progress* into whose design and construction, *safety* and *economy* are incorporated as paramount essentials. The massive columns of this huge structure were welded with

HOLLUP ELECTRODES

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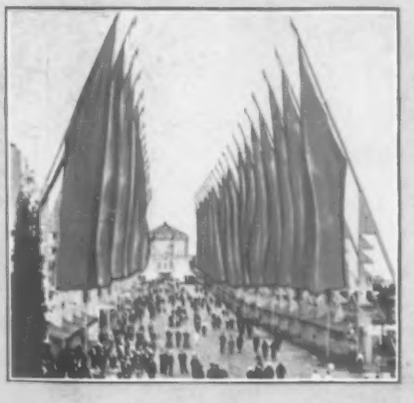
47 standards the "Avenue gs"—the im- entrance to orld's Fair— welded with p Electrodes.



Hollup Electrodes were used in welding the standard frame sections of the house of General Houses, Inc., built at the World's Fair.

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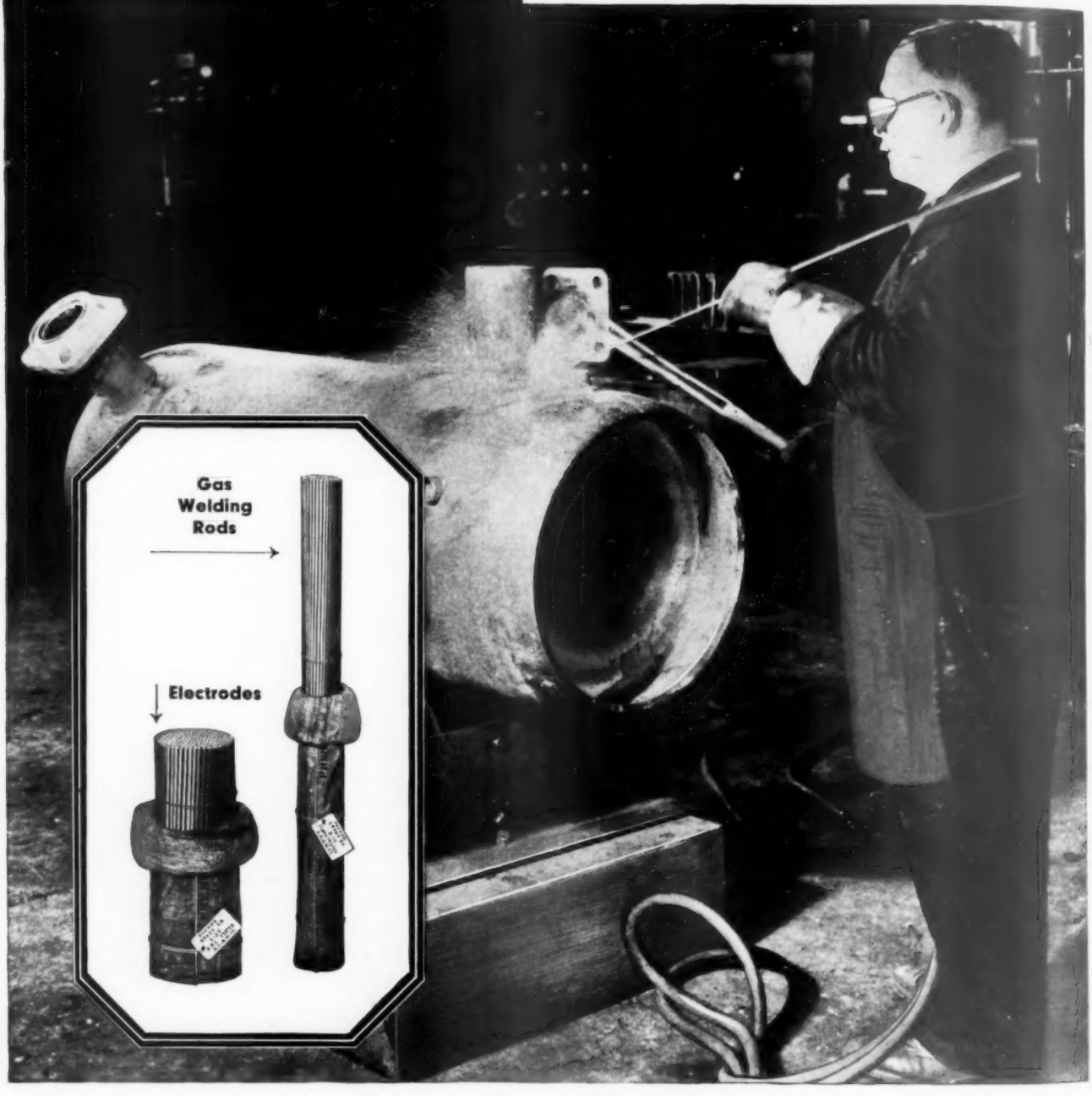

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THE WELDING ENGINEER

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Published on the 15th of each month by The Welding Engineer Publishing Company, 608 S. Dearborn St., Chicago, Ill. Telephone Webster 7134.

G. H. Mackenzie, *President and Treasurer* K. B. Mackenzie, *Secretary* F. L. Spangler, *Editor*

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PACIFIC COAST: W. R. McIntyre, 1115 Tyler St., Glendale, Calif.

Subscription, payable in advance: United States and possessions, $3 a year; Foreign Countries, $4 a year; Canada, $4 a year; Single copy, domestic, 25 cents; Single copy, foreign, 30 cents. Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

FOREIGN REPRESENTATIVES: GREAT BRITAIN—Capt. D Richardson, 26 Winterbrook Road, Herne Hill, London; AUSTRALIA and NEW ZEALAND—R. Hill, Matlock House, Davenport, Auckland, New Zealand; SOUTH AFRICA—J. W. Arnison, 35a Victoria Avenue, Benoni, Transvaal, South Africa.

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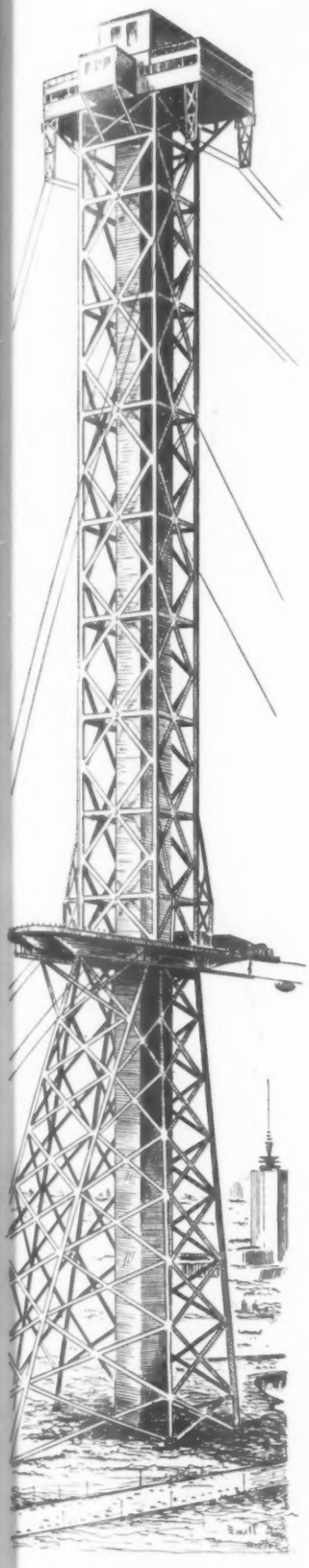

Westinghouse-welded

Sinews of Steel support these giant towers

AT the Chicago World's Fair, two giant steel towers stand as monuments to the practicability and economy of arc-welded structures and to the acceptance of this construction method by progressive engineers. Fused in the mighty legs of these 600-foot towers are strong welded steel sinews . . . the mark of a new and proved method in structural steel fabrication.

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The Westinghouse Weldomatic fabricating one of the main column sections for the Sky Ride at the Chicago Century of Progress Exposition. This work was done in the Mississippi Valley Structural Steel Company's Chicago District Plant.

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Welding at "A Centur

NOTE: Any of the features described is readily located on the Fair grounds by referring to the number in parentheses and locating the corresponding arrow in the view at the bottom of pages 20 and 21.

MANY miles of welded handrailing, hundreds of welded flagpoles and lighting standards, two huge structural towers in which 19 miles of automatic welding bead was laid, an automobile tier parking machine in operation in which almost all parts were cut by the torch and welded, actual demonstrations of welding—these are a few of the highlights at Chicago's International Exposition, A Century of Progress, that will interest those in the welding field.

As the visitor approaches the main entrance to the Fair Grounds, at 12th Street, he goes over a pedestrian bridge the tubular columns of which are capped at both ends with welded plates and stiffener angles.

Flagpoles and Standards

Just inside the main entrance gates is the Court of Honor (*13*), consisting of eight flagpoles surrounding a circular garden. In the walk from this point south to the Science Building, which is the usual course the crowd takes, one passes along the Avenue of Flags (*12*), lined on each side with all-welded standards inclined at an angle and with canopies supported by all-welded posts.

On every hand one sees various types of welded standards for lighting the grounds and for floodlighting the buildings, as well as for carrying loud speakers for broadcasting music and announcements throughout the grounds.

Welded flagpoles are numerous. The usual method of forming these is to insert each section of pipe several inches into the pipe section just below, then plug-weld near the bottom of the smaller section and lay a fillet weld around the top edge of the large section. This makes a sturdy joint that does not set up high stresses in the fillet weld in high winds. A 60-mile gale with rain suddenly came up from the west on the evening of June 4th, but every welded pole and standard on the ground stood this terrific test with no failure whatever, though the wind was sufficient to tear many of the flags from their standards.

The Visitor's First View as He Enters the Fair Grounds Is the Welded Flag Poles of the Court of Honor.

The "Sky Ride"

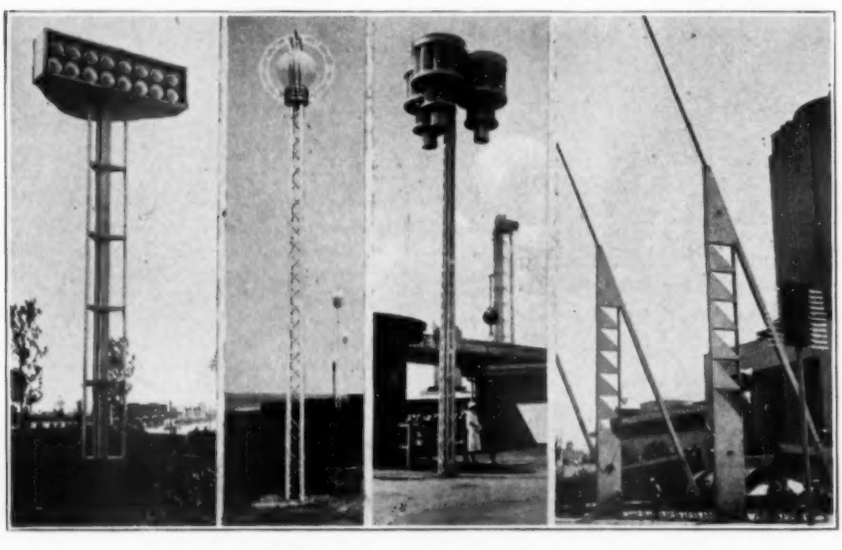
In the application of welding to structures, of greatest interest is the two welded towers of the Sky-Ride (*10*) separated by 1850 ft. and rising 625 ft. into the air. The four main columns and struts and diagonals on each tower were welded in the plant of the Mississippi Valley Structural Steel Co. The column sections are formed of three I-beams to make an H-section, and the diagonals and struts are formed of plates and channels. The welded structural members were delivered to the site and there joined by riveting. Some idea of the size of the columns is obtained from the fact that the bottom sections consist of two 20-in. I-beams and one 15-in. I-beam welded together to form the H-section, and the completed section weighs 390 lb. per linear foot. These sections decrease in weight as they approach the top, the topmost sections weighing 174 lb. per linear foot.

Base of Sky-Ride Column Showing Welded Members.

In addition to the main and secondary members, welding was also used in the construction of Z-bar supports for holding in place the rock-wool insulation of the elevator shaft, as well as for the column-base details, door and window mullions and jambs, ladders, and handrails.

Between the towers is spanned a cableway of Roebling wire along which travel ten rocket-shaped cars, each having a capacity of 36 passengers and pilot. The framework of these cars is of tubular construction with all joints welded.

A display featuring the construction of the Sky-Ride has been set up in the Travel and Transport Building (*2*). This includes a full-size section of one of the columns at the 200-ft. level and a section of a main strut and of an intermediate



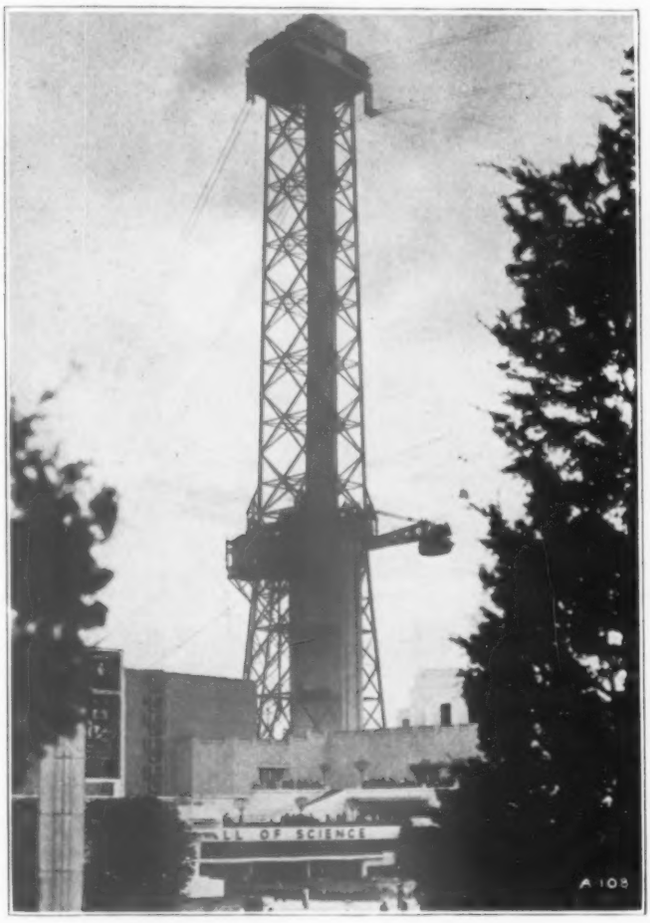
Examples of Welded Standards at A Century of Progress.

Progress"

■

Welded construction is evident on every hand, and the welding and cutting processes are daily being demonstrated before multitudes of visitors.

■



strut, all welded, with also an automatic welding head displayed.

A section of a Sky-Ride member with an automatic welding head in position, illustrating the set-up for welding, is being shown in the large display of the General Electric Co. in the Electrical Building (*15*).

A full description of the welded construction of the Sky-Ride was given in the January, 1933, issue of THE WELDING ENGINEER.

Structural Welding

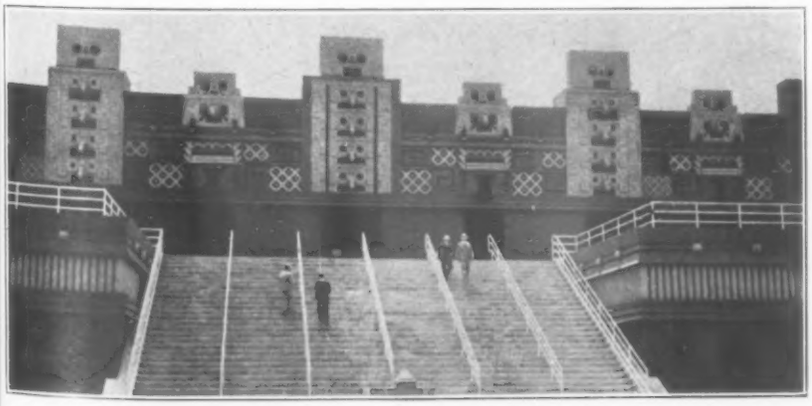
Another interesting application of structural welding is the 16 large arches in the General Motors Building (*4*) supporting the roof over the floor where Chevrolet cars are being assembled.

These arches have a span of approximately 95 ft. and a maximum height of approximately 44 ft. Each arch was made in three sections, there being a section on each end and one at the top. Each section was fabricated in the shop by cutting and welding, and the sections were fastened together in the field by riveted splice plates. At the points of bending in each section, a wedge-shaped piece was cut out of the I-beam by the torch, with the point of the wedge just below the upper flange, so this flange was not cut but was continuous along the entire section. The beam was then bent at this point, making a butt joint, which was filled with weld metal. Riveted cover plates were applied to the top surface of the lower flange of the welded joints, but the design is such that the welds take the entire load.

Welding was also used in fabricating the structural framework of the 16-ft. revolving dome at the top of the Sears-Roebuck Building tower (*11*). The stainless-steel covering of the dome is supported by ribs made of T's bent to the proper radius. This frame is carried on eight wheels running on the inside web of H-beams which were curved to the proper radius and welded to a supporting framework.

With the exceptions of the Sky-Ride towers, the Sears dome and the General Motors arches, the application of welding to the Fair structures has been limited almost entirely to the bridging between the floor joists. This bridging is welded in all the main buildings except the Travel and Transport Building. Where the bridging is exposed, rounds are used, two rounds being placed diagonally between adjacent joists, with the ends welded to the steel joists and a weld being made in the middle where the rounds cross. This makes a neat, rigid design.

Where the floor joists are covered so they are not seen, small sections of chan-

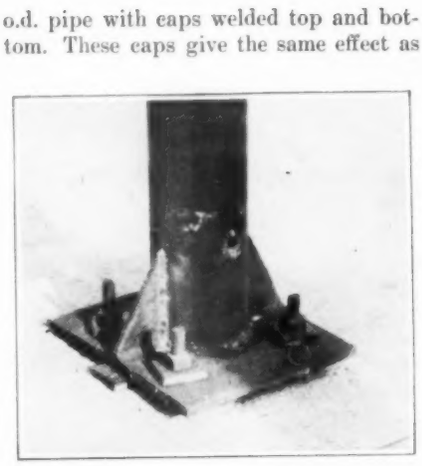


The Ancient and the New! **Replica of a Centuries-Old Mayan Temple, in Which Every Part Is a Faithful Reproduction of the Original—** ***Except the Welded Handrails.***

nels were used for bridging, these being welded at their ends only.

Welding would have been used to a far greater extent in structural framework, were the Fair buildings to be built for permanency. The buildings are only temporary structures, to be torn down when the Fair closes in November. It was the opinion of the Fair officials that bolting and riveting would allow a better and cheaper job of dismantling than if the steel were welded. Therefore there was no welding of the structural members in those buildings erected by the Fair.

An interesting design of welded column plates can be seen at the two-deck promenade extending for a distance of 360 ft. north from the Chrysler Building (*3*). This promenade is supported by 91 columns consisting of sections of 5½-in.-o.d. pipe with caps welded top and bottom. These caps give the same effect as plates, but actually are T-sections cut from 14-in. Bethlehem beams. The web of each cap is fitted through two slots cut in the end of the pipe with the oxy-acetylene torch, and the flange, which forms the bearing plate, comes up against the end of the pipe. Fillet welds join the pipe to the web and flange. The flanges are bolted to the concrete bases and the overhead joists. With this design, there is no noticeable warpage of the flanges after the laying of the ⅜-in. fillet welds.



Column Base Cut From I-Beam, Inserted in Slots in Column, Then Welded.

A similar design of welded column plates is used on the 23 columns supporting a canopy at Pabst's Blue Ribbon Casino (*14*).

Those who find interest in welded storage tanks of various types should visit the exhibit of the Chicago Bridge & Iron Works in the first unit of the General

WHAT TO SEE IN WE

(16) AGRICULTURAL BUILDING.
Welded aluminum truck-tank displayed in International Harvester Co. exhibit.
Concrete floor around General Foods booth sprayed with brass by metal-spraying process.

(12) AVENUE OF FLAGS.
Street lined with 47 all-welded standards and with canopies carried by welded pipe supports.

(3) CHRYSLER BUILDING.
Columns of promenade extending north from building have plates, torch-cut from H-beams, welded at top and bottom.
Exhibit of Chrysler body in five sections, showing location of flash welds by means of neon lights.
Exhibit of body of Plymouth car after welding.
Flash-welding operations illustrated by motion picture in theater in building.

(13) COURT OF HONOR.
Eight all-welded flagpoles surrounding circular garden plot.

(15) ELECTRICAL BUILDING.
Demonstration of automatic welding head welding pipe, in Central Station exhibit.
Section from one of structural members of Sky-Ride, with automatic welding head, illustrating set-up for welding, in General Electric Co. exhibit.

Huge vacuum cleaner made of plaste
coated with cadmium by metal sprayin
exhibit in Hoover Co. booth.

(8) GENERAL EXHIBITS GROUP.
Products of welded stainless steel in U
Steel Corp. exhibit.
Colored transparencies illustrating we
storage tanks, in exhibit of Chicago Brid
Iron Works.
Examples of metal spraying: Mural
booth of Brunswick-Balke-Collender
Lion's head, hemisphere, and huge Ma
lock in booth of Master Lock Co. Large
in moving exhibit in booth of National C
Register Co.

(4) GENERAL MOTORS BUILDING.
Sixteen arches over large assembly h
consisting of 18-in. I-beams, torch-cut, b
and welded at joints.
Two flash welders in operation in assem
line.
Portable all-welded waste hoppers on
sembly floor.

(5) HOME PLANNING BUILDING.
Several manufacturers are displaying
mestic heating furnaces of welded steel
struction.

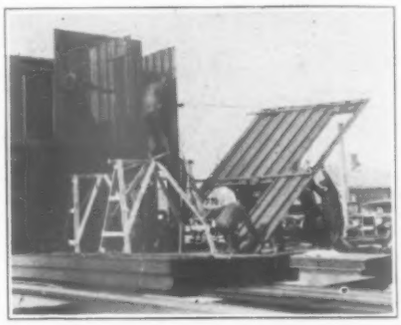
(6) HOUSING GROUP.
Armco-Ferro frameless steel house
welded wall sections and door and win
frames.

From a Painting of "A Century of Progress" by H. M. Pettit, for Rand McNally & Co.

Exhibits Group (*8*). Here are shown views of a number of elevated water tanks and oil storage tanks of all-welded construction. Colored transparencies, in connection with two automatic slide machines, are used for illustrations.

From the standpoint of welding and cutting, the tier parking machine in operation in the Nash Whiting Tower (*1*) is of deep interest because of its all-welded design and the fact that all pinions, links, plates, structural members, and some of the gears were cut out by an oxy-acetylene shape-cutting machine and are welded. This parking tower, which is described more fully beginning on page 32 of this issue of THE WELDING ENGINEER, shows skillful design and workmanship throughout.

Among the smaller welded structural work at the Fair, one of the most interesting is the Armco-Ferro frameless steel house in the Housing Group (*6*). The method of construction of this house is slightly different from that of the experimental house built in Solon, Ohio, a few months ago and described in the October, 1932, issue of THE WELDING ENGINEER. In the present house, the wall sections were rolled full house high and then welded together with a spot-welding machine. All door and window frames were welded into place before leaving the factory. At the site, the floor and wall sections were fastened together with sheet-metal screws. In the welding together of the Z-shaped sections forming the floor unit, a special resistance welder makes two welds simultaneously, one on the top plane and one on the lower.



Erecting a Wall Section of the Frameless House.

After the wide floor sections were laid in place on the foundation, the outside-wall sections were upended in their proper places one after the other, after which metal conduits were welded onto

G AND ALLIED FIELDS

Welding is used in the design of the standard frame sections in the house built by General Houses, Inc.

(1) NASH WHITING TOWER.

Tier parking machine carrying 16 latest Nash models on display. Pinions, links, gears, structural members, etc. cut with the torch and arc welded. All welds and cuts show high-grade workmanship.

(3) PABST'S BLUE RIBBON CASINO.

T-sections torch-cut from H-beams and welded to top and bottom of 23 tubular columns supporting canopy.

(9) SCIENCE BUILDING.

All-welded aluminum gondola used in second stratosphere flight by Auguste Piccard, on display in main hall.

Huge globe in main hall supported by welded framework.

Demonstration of thermit process on small scale.

Demonstrations and exhibits on gas welding and hard facing, with equipment used, in exhibit of Union Carbide & Carbon Corp.

Radiographs of welds and diffraction patterns shown in booth of General Electric X-Ray Corp.

Demonstration of how polarized light is used to determine distribution of stresses.

(11) SEARS-ROEBUCK BUILDING.

Revolving dome supported by welded framework.

(7) SINCLAIR EXHIBIT.

Life-like prehistoric animals actuated by internal motors. Frames of beasts are of all-welded steel construction.

(10) SKY-RIDE.

Two steel towers 625 ft. high, with main columns, struts and diagonals shop welded and field riveted. Z-bar supports, floor plates on observation platforms, column-base details, door and window mullions and jambs, ladders, and hand railing are also welded.

(2) TRAVEL AND TRANSPORT BUILDING.

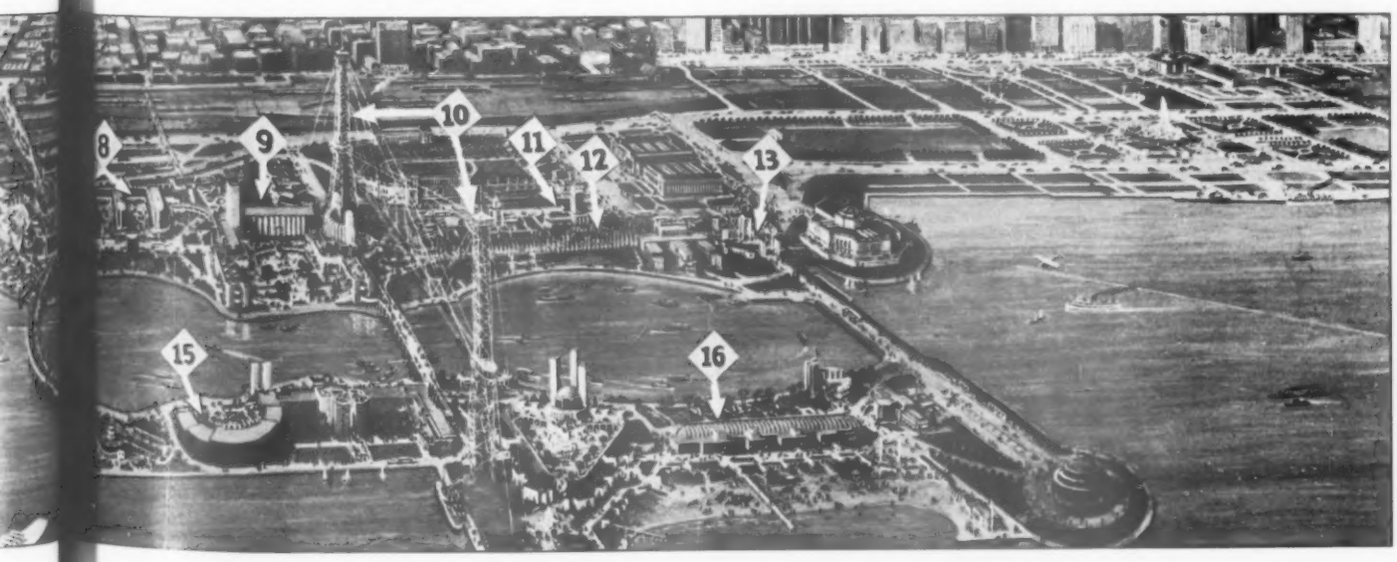
All-welded hopper car with one-piece cast-steel underframe on railroad siding south of building.

Car for transporting milk, with welded glass-lined tanks, on display in building.

High-speed commercial transport plane, with many welded parts, on display under building dome.

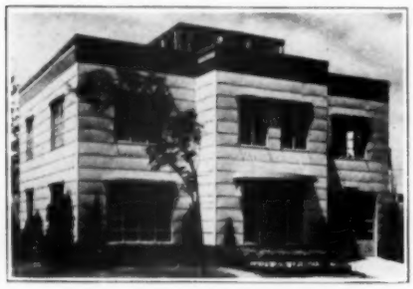
Demonstration of arc welding and electric-torch cutting in booth of Harnischfeger Corp.

Exhibit featuring Sky-Ride, with actual sections of welded structural members, and automatic welding head, illustrating method of welding of structural sections.



these wall sections at the ceiling line of both the first and second stories, these serving as continuous floor brackets. The upper floor sections and roof were then lifted into place and securely fastened to to the side walls. Finally, the glass-and-steel solarium was erected on the roof, thus completing the metal chassis of the house, which was then covered with insulation and porcelain-enamel siding put on.

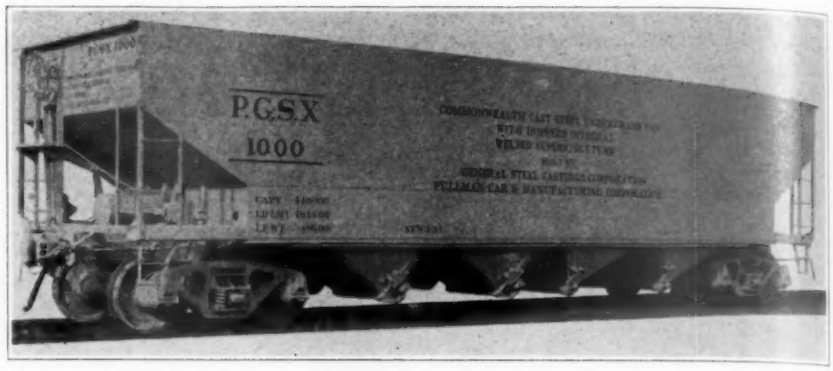
Some welding was used in the shop construction of the standard units forming the framework of the house erected by General Houses, Inc., which is also in the Housing Group.



Welded Frameless House on Exhibit in the Housing Group at the Fair.

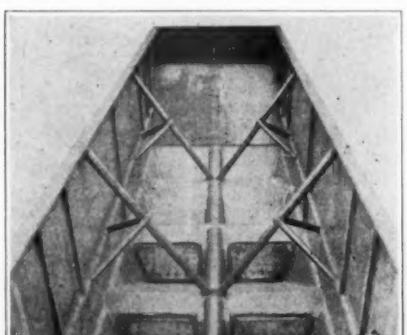
A welded structural framework supports a 10-ft. Rand-McNally globe on display in the main hall in the Science Building (*9*).

An unusual application of welding is in the design of the frames of the seven life-size dinosaurs in the Sinclair Exhibit (*7*). Heretofore wooden framework was used by P. G. Alen in the making of life-size animals for the motion-picture industry, but in this exhibit Mr. Alen substituted welded steel, mostly 1x¼-in. stock, for wood. These animals were patterned after small clay models and were carefully checked by experts for accuracy of detail. These dinosaurs, the largest of which measures 70 ft. from snout to tip of tail and weighs 2½ tons, also requires certain other building compositions, such as plaster and rubber. They are waterproofed to protect the delicate electrical mechanisms that give them life and they are strong enough to withstand the summer gales blowing over the Fair Grounds.



Hopper Car With Welded Superstructure.

A hopper type of railroad car with a single cast-steel underframe and welded superstructure is on exhibit on the railroad siding immediately south of the Travel and Transport Building (*2*). This construction results in greater strength and durability with less weight. The underframe, of which the eight hoppers are an integral part, replaces 170 pieces and approximately 2000 rivets.



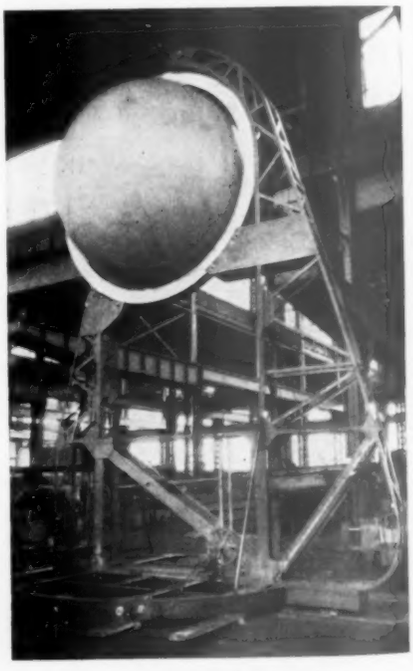
View of Inside of Welded Car.

Under the dome in the Travel and Transport Building (*2*) the latest type of Boeing high-speed plane is on display. Sixty of these planes are being built for the United States Air Lines. The engine mounts, wing joint fittings, spar joints, tail gear and many other parts of this plane are welded. The plane has a capacity of 13 people, including two pilots, and a cruising speed of 171 miles per hour.

A railroad car with glass-lined welded steel tanks is on exhibit for public inspection in the Travel and Transport Building (*2*).

An interesting example of economical steel fabrication is a number of portable waste hoppers on the assembly floor in the General Motors Building (*4*). These are constructed of angles and plate cut to size and shape and welded together.

In the Home Planning Building (*5*) several manufacturers of domestic heating furnaces are showing their products made of welded steel, with almost a complete elimination of castings.



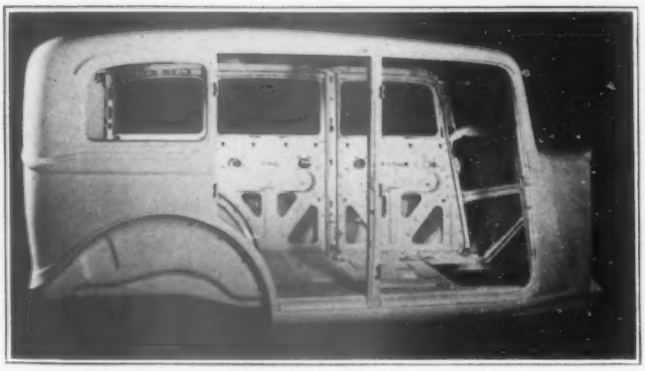
View of Globe and Supporting Framework After Welding.

Welded Skeleton, 70 Ft. Long, of the Brontosaurus, for the Sinclair Prehistoric Exhibit.

Welded Aluminum Products

A truck-tank built by the Farrell Manufacturing Co., Joliet, and made of 3S half-hard aluminum with all seams welded by the oxy-hydrogen process is being shown in the display of the International Harvester Co. in the Agricultural Building (*16*). This tank has a

This Welded Aluminum Truck-Tank Is One of the Features of the International Harvester Exhibit.



Flash-Welded Automobile Body on Display in the Chrysler Building.

pay-load capacity of 1850 gallons of gasoline, or about 500 gallons more than could be carried if the truck-tank were constructed of steel instead of aluminum, without exceeding the desired weight. Though the aluminum tank weighs only about half what a steel tank would weigh, it costs about $1100 more, and is of somewhat thicker gage than a steel tank, but the additional carrying capacity pays for the higher cost of the tank and truck in one year. The tank alone weighs 2830 lb. All welds are ground down, and the finished welded seams have an efficiency of approximately 90%. The truck and tank weigh 11,000 lb., unloaded, compared with about 14,000 lb. for a truck with tank of steel.

Another example of welded aluminum construction is the spherical basket or gondola, used by Professor Auguste Piccard, renowned Swiss scientist, in his balloon ascension into the stratosphere last August. This gondola is of pure aluminum and was brought over to this country for A Century of Progress, where it is being exhibited in the main hall in the Science Building (*9*). A description of this gondola, as well as the one being constructed for the stratospheric flight to begin on or after July 1st from the Fair Grounds, is given in an article beginning on page 30 of this issue of THE WELDING ENGINEER.

In the exhibit of the U. S. Steel Corp. in the General Exhibits Group (*8*) are shown some interesting examples of welded stainless-steel products.

Automobile Welding

The general public is showing great interest in the spectacular display of the two flash welders in operation on the assembly floor in the General Motors Building (*4*) where they are making Fisher bodies. The larger of these is a 14-ton machine which welds in two operations the side panels to the back panel. A 50-in. weld is made in each operation, and only 35 seconds elapses between the time the three panels are clamped into the machine and when they are taken out as one piece. The smaller welder fuses the roof rail cover panels to the front ends of the side and rear panel assembly, after which all seams are further reinforced by welding and then the surplus metal is ground off. All these operations are performed as the public looks on from the balcony surrounding the assembly floor.

Research is the keynote of the exhibit in the Chrysler Building (*3*). Here is displayed the unfinished body for a Plymouth car in which the flash welds are plainly visible. There is also an animated display in which the five integral parts—the side panels, rear panel, cowl and floor pan—of a Chrysler body are moved together and then neon lights flash to show the line of welds. In a theater in this building, resistance welding and the other operations in the making of automobiles are illustrated.

Flash Welder in Operation in the General Motors Building.

Metal Spraying

In the General Exhibits Group (*8*) are several interesting examples of metal spraying.

In the Brunswick-Balke-Collender Co. exhibit are 320 sq. ft. of plaster murals that were "metallized" with four coats of tin, the metal being sprayed onto these murals after they were in position in the exhibit.

A 4-ft. lion's head, made of plaster and coated with a 0.008-in. layer of cadmium by "metallizing," then finished with steel wool, is on display in the booth of the Master Lock Co. A hemisphere of plaster, treated similarly to the lion's head, is in the same booth, as is also a Master lock, 4 ft. high, constructed of wood and then metal sprayed with cadmium.

Forty wooden coins, sprayed with metal to appear like the real thing, roll in and out of a huge cash register mounted on the top of a globe in the exhibit of the National Cash Register Co. These coins represent the money of ten different countries. They first were sprayed with lead. Then some were coated over with copper, others with cadmium to represent silver, and still others with brass to imitate gold. After the finishing coat of metal was sprayed on, the coins were sandpapered.

A large job of metal-spraying is evident at the General Foods booth in the Agricultural Building (*16*). Here an 18-in. strip along the concrete floor at each end of the booth and 8 bays, 7x20 ft., were coated with brass by the metal-spraying process. The area covered totals 1200 sq. ft. of floor, and approximately 400 lb. of brass was sprayed.

Another example of metal spraying is in the exhibit of the Hoover Co. in the Electrical Building (*15*). A huge vacuum cleaner made from plaster by the Architectural Decorating Co. and being an exact duplicate of a Hoover cleaner magnified ten times, with fittings such as switches and screw heads made of wood, was sprayed with 80 lb. of cadmium. A total area of 160 sq. ft. was covered.

Demonstrations

In booth J. group 9, Travel and Transport Building (*2*), the Harnischfeger Corp. is demonstrating arc welding with a P&H Hansen welder, and also has an electric torch in operation cutting metal. This demonstration includes the welding of brass, bronze, aluminum, tin, cast iron, and steel. The booth is provided with a panel of various metals welded together.

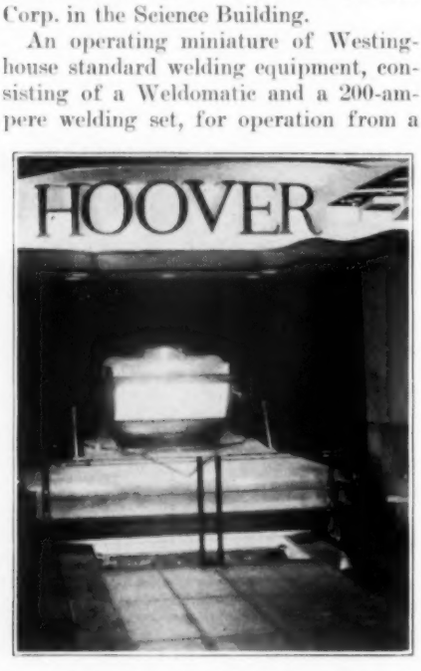
Just west of the main hall in the Science Building (*9*) is a demonstration of the thermit process, of which the Metal & Thermit Corp. are sponsors, in which the chemicals are automatically discharged in their proper proportions from two glass jars into a cup and then ignited

Sprayed With Tin, These Plaster Murals Give the Appearance of Being Etched Out of Metal.

with an arc. Near this exhibit is also a demonstration of the use of polarized light for determining the location and extent of stress concentrations in stressed materials.

A demonstration of gas welding and hard facing, together with a display of the equipment used, is being given in the exhibit of the Union Carbon & Carbide Corp. in the Science Building.

An operating miniature of Westinghouse standard welding equipment, consisting of a Weldomatic and a 200-ampere welding set, for operation from a



Eighty Pounds of Cadmium Was Sprayed Onto This Huge Vacuum Cleaner.

200-volt, 3-phase, 60-cycle supply, and a working model of a tank rotating device, may be seen in operation, at the exhibit of the Westinghouse Electric & Manufacturing Co. in the Electrical Building (*15*), in connection with the central station exhibit. The equipment shown, because of its diminutive size, is being demonstrated in welding pieces of pipe, and illustrates how it is used in automatically welding tank ends, although it has many other applications in industry.

A showing of radiographs of welds and diffraction patterns taken with the X-ray can be seen in the booth of the General Electric X-Ray Corp. in the General Exhibits Group (*8*).

Thus far, only the highlights of welding at A Century of Progress have been mentioned. No reference has been made to welded water pipes, and other matter-of-fact aplications of the welding process. Neither does space permit going into the matter of how welding was used to build the Fair, as for example in the hard-facing of the dipper teeth used to move materials on land and on the sand-sucker which built up the land on which the Fair is held. All in all, the Fair is a grand demonstration of the important part welding and the allied processes play in industry and commerce.

Many of the data in this article were obtained from the Duffin Iron Co., Western Welding & Boiler Repair Co., Mississippi Valley Structural Steel Co., Gage Structural Steel Co., Metallizing Co. of America, The American Rolling Mill Co., Chicago Bridge & Iron Works, K. D. Falk, Dow Chemical Co., Sinclair Refining Co., and others, to whom grateful acknowledgement is made.

All-Welded Ornamental Arch for U. S. Navy

The U. S. Navy recently awarded a contract for the fabrication of an all-welded ornamental iron arch for the entrance to the San Diego, Calif., marine base. This arch is approximately 35 ft. long and is a beautiful piece of welded fabrication. Specifications, called for 100% welded construction, and the job was handled by the Standard Iron Works, of San Diego.

Advanced Course in Welding

July 10th is the date set for the beginning of another advanced welding course to be given by the John Huntington Polytechnic Institute, Cleveland, Ohio. This course, to be repeated due to the success of previous ones, is designed to give engineers and experienced operators an opportunity for a week's intensive study from both the practical and theoretical standpoints.

The hours from 8:30 a.m. to 3:30 p.m. each day will be spent at the plant of The Lincoln Electric Company, which has offered the facilities of its welding school. Evenings from 6:00 to 8:00 o'clock will be occupied by lectures at the John Huntington Polytechnic Institute.

Study at the welding school will include practice, demonstrations and lectures on welding machines, electrodes and automatic welding. Not a little time will be devoted to the welding of alloy steels and non-ferrous metals.

The evening lectures will consist of discussions of welding electrodes, weld metal, calculations of weld strength, shape of beads and stress concentration, designing for welding, supervision and inspection of welds and allied problems.

The only charge for the course is for materials used in practice work. Those enrolled will have the opportunity of consultation with the instructor on their special problems.

Complete information on the course may be obtained from E. W. P. Smith, Welding Engineering Department, John Huntington Polytechnic Institute, Cleveland, Ohio.

Brockson Completes Year as Head of Advertisers

Under the direction of W. I. Brockson, president, who is a frequent contributor to THE WELDING ENGINEER, the Engineering Advertisers Association, Chicago, is closing a very successful year despite the business conditions which have prevailed. During the year 25 new members were added to the rolls and the average number of members and guests attending the meetings has been increased. One significant accomplishment — unique in association work—has been the work of research committees in making cooperative studies of specific selling and advertising problems. This organization is affiliated with the National Industrial Advertisers Association, who are holding their annual convention in Chicago on June 26th to 28th.

The Resistance Welding of Aluminum and Its Alloys

■ By D. I. BOHN and G. O. HOGLUND
Aluminum Company of America

ALUMINUM and steel are both metals, but this is about the only thing which they have in common from the standpoint of resistance welding. The tabulation of the properties of mild steel and of three commonly used aluminum alloys, given at the bottom of this page, will serve to emphasize these differences in characteristics.

So far as it has been developed, resistance welding of aluminum alloys must be made with the metal in a molten state, when it obviously has no mechanical strength. In addition, the high thermal conductivity of aluminum tends to equalize temperatures throughout the material at an extremely rapid rate, so that for successful work the temperature gradient must range from above melting at the point of weld to well below melting at the point of contact with the electrodes, which may be only a few thousandths of an inch away. If this condition does not exist, alloying of the aluminum alloy surface and the electrodes will occur. These considerations apply to all forms of resistance welding, but particularly to spot and seam welding.

CORRECT procedures for use with the spot, seam, and flash methods of resistance welding are outlined in this paper to be read at the semi-annual meeting of the American Society of Mechanical Engineers, Aeronautic Section V, at Chicago, June 27, 1933.

Consistent Results Not Obtainable in Past

For years results of varying degrees of success have been obtained when a conventional automatic spot welder, as used for steel, was employed for welding aluminum alloys. Lack of consistency of results characterized much of this work, and initial investigations were directed toward determining the cause of this inconsistency.

The application of pressure on the conventional automatic spot welder is obtained by means of a motor-driven cam and spring, and the time of power application is governed by an a.c. contactor actuated from a non-synchronous cam-operated pilot contact. The time in seconds during which this contact remains closed for a given setting is very nearly constant; and the large errors in time of power application, as observed oscillographically, show that practically all of these errors come from the inherent characteristics of the a.c. contactor.

Variations up to one-half cycle would be expected in the closing of the contactor, depending on the point on the wave when the contactor coil is energized. It might also be expected that a similar condition would exist with respect to the opening of the contactor; this is not the case, however, as the effect of the shading coil aggravates the holding-in characteristic, and time errors much greater than those observed in closing are obtained in opening.

These errors are of no particular moment when welding steel, as an extremely short time of power application is not required. It is evident that errors of one or two cycles mean very little when the time of power application is from ten to thirty cycles. When a short time setting, such as one to four cycles, is used, these errors themselves are sufficient to completely wreck the consistency which otherwise might be expected.

Thermal Gradient Through Sheet Must Be High

The basis of successful spot welding is an extremely high thermal gradient from the weld to the surface of the sheet, and this makes necessary that the time of power application be short. If the time of power application is a little too long, molten metal will be observed at the point of electrode contact; and if it is still longer and sufficient power is used to cause an interior molten condition, the sheets themselves will melt through and the electrodes will come together. The ideal spot weld would therefore be a power application of infinite amount for zero time.

Relatively minor changes are required to make reasonably good spot welds in aluminum alloys using the conventional automatic spot welder, provided the welder is of sufficient electrical capacity. This latter point is important and must be emphasized for all types of resistance welding, as we know of no way to satisfactorily compensate for insufficient welding current.

By providing the a.c. contactor with a d.c. operating coil and a series resistor and operating it from a convenient source of 125 or 250 volts d.c., the great inherent time variation of the a.c. contactor will be eliminated. This will not insure synchronous control—a desirable feature—but it will be enough of an improvement to permit most commercial jobs to be handled satisfactorily.

Projection Type of Electrode Gives Good Results

Even without the use of synchronous control, very consistent results may be obtained by using a special design of electrode. This electrode design is shown in Fig. 1 and consists primarily of two flat electrodes, one of which has been machined with a small projection in the center. An aligning device is necessary to insure parallelism of the faces when pressure is applied.

Assume that the electrodes are in contact with the sheets to be welded and that the power is applied, let us say, for approximately four cycles, as determined by the motor-driven cam setting. Let us also assume that sufficient energy is applied so that the proper weld will be completed in two cycles. It is at this point that power should be removed from the weld, and it is the inherent characteristic of this tip to take care of this feature.

When the molten bubble has reached a certain size, the non-molten metal contacting the small projection on one of the electrodes becomes thin enough to permit the projection to sink into the surface. When this occurs the entire face of

Properties of Aluminum Alloys and Mild Steel.

Material	Specific Heat	Thermal Conductivity	Electrical Conductivity	Brinell Hardness	Melting Temperature
2S-½H	.22	.51	58%	32*	1191°-1220° F.
53SW	.22	.36	40%	64*	1085°-1200° F.
17ST	.21	.27	30%	100*	963°-1193° F.
Mild Steel	.12	.12	15%	110**	2500° F.

*500-kg. load on 10-mm. ball. **3000-kg. load on 10-mm. ball.

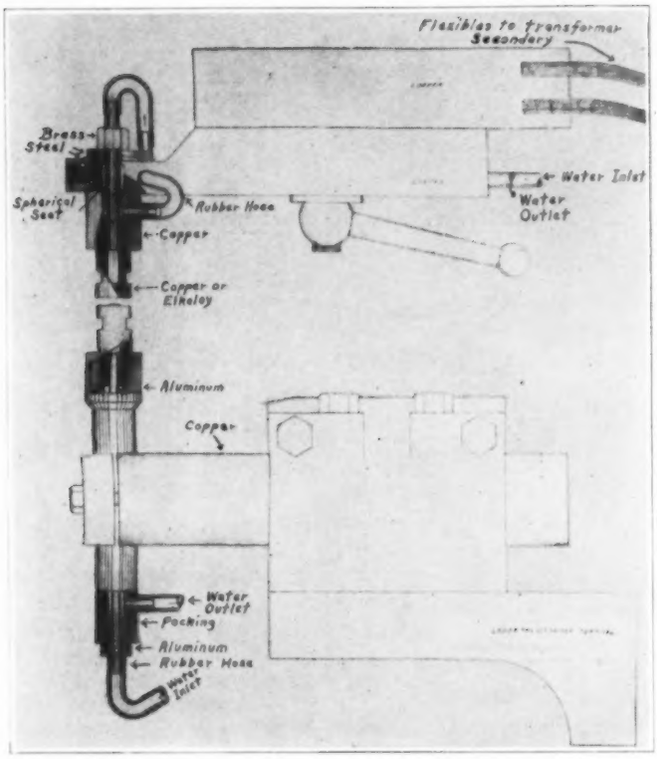


Fig. 1. Spot Welder With Projection-Type Electrode. View Is One-Sixth Actual Size.

both electrodes becomes available for carrying current and the current density through the weld is decreased to a negligible value. As will be seen, this will occur automatically, and whether the time of contact opening is one cycle or three cycles after this has occurred will make no appreciable difference in the weld.

This method has been used quite successfully in making some compression test members, all of which showed higher values of failure than did duplicate riveted members. It is clumsy to apply in some cases and also requires special facing apparatus to maintain the tips in their proper condition. For this reason it is of somewhat limited application, but may be definitely used to produce excellent spots where a minimum of expenditure is desired and existing equipment must be used.

No mention so far has been made of electrode pressures. These are, in any event, a compromise.

Effect of Aluminum Oxide Film on Sheets

All aluminum alloys have more or less of a high-resistance oxide film on their surface. The effect of this is both desirable and undesirable. It tends to produce melting at the electrode contacting point, but it also permits a weld to be made with less current than if it were not present between the sheets. Also, since it is by no means a constant or definitely known factor, it introduces one variable which is always present.

The contact resistance between two aluminum alloy sheets or between an electrode and a sheet decreases greatly with an increase of pressure. For this reason alone a sufficient electrode pressure must be applied to insure no undue surface heating at the contact of the electrode. Also, the percentage of resistance variation normally expected between the sheets becomes a less amount with high pressure.

The hardness and yield strength of the alloys being welded determine the upper limit of pressure, but as a general rule the range between the permissible lower limit and upper limit is quite large, and satisfactory work can be done through a considerable range. This does not mean however that variations in pressure may be permitted in successive spots, as with a given setup the pressure of successive spots must be accurately maintained.

Electrode Design for Use With Thyratron-Tube Control

If some form of synchronous control of power supply is available, extremely consistent results will be obtained by using an electrode design as shown in Fig. 2. This design is a compromise between the conventional pointed tip and the projection type of tip previously discussed.

If the pressure control is accurate, the line voltage constant, and the power application of a synchronous and exact nature, the only remaining variable is the contact resistance between the sheets caused by the oxide film. By using reasonably high pressures, this variation is not serious, using this type of electrode which to some extent compensates for its variation. The conical shape of the tip provides a natural stability in that the area increases rapidly, tending to lower the current density as the tip sinks into the surface of the metal. It does not suddenly lower the current density to a negligible value, as in the case of the projection type of electrode, but equally consistent results are obtained with the precision conditions mentioned.

This design has practical advantages over the projection type in that accurate aligning is not necessary, and many variations of general design permit it to be worked into complicated structures and curved surfaces to a better advantage than the projection tip. This tip has been used in conjunction with the thyratron-tube control and the results are about the same as have been observed with the projection type.

"Common" Alloys May Not Require Surface Cleaning

The aluminum alloys may be classified as "common" and "strong" alloys. The former come in varying degrees of temper, depending on the amount of cold work, and are non-heat-treatable. For this reason their oxide film is fairly constant and offers but a low contact resistance so that, in general, spot welding with the common alloys does not require

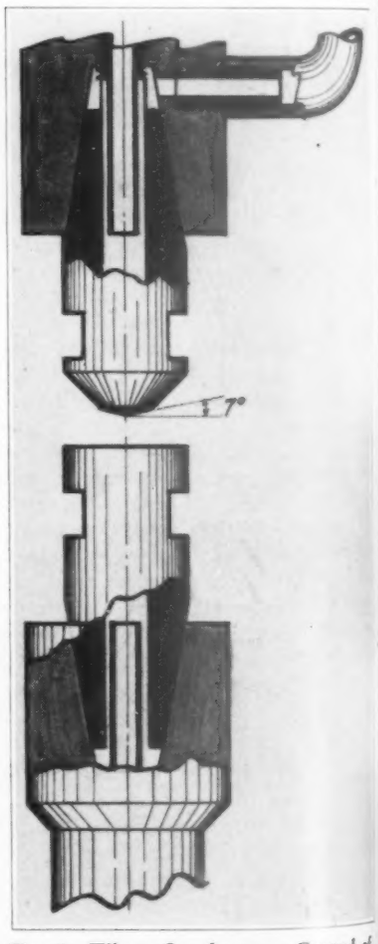
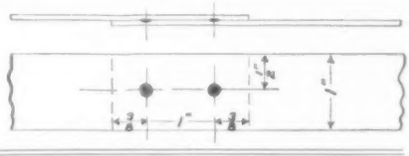


Fig. 2. Where Synchronous Control of Power Is Provided, One Electrode Can Be Furnished With a Conical-Shaped Tip. View Is Two-Thirds Actual Size.

Strength of Spot Welds in the Aluminum Alloys.

Alloy	Gage, In.	Average Breaking Load, Lb.	Average Breaking Load per Spot, Lb.	Per Cent Variation from Average	
				Plus	Minus
4S½H	0.020	465	233	21.0	14.0
4S½H	0.032	869	435	5.5	8.3
4S½H	0.040	1030	515	6.0	3.0
4S½H	0.081	2124	1062	3.1	5.0
3S¼H	0.032	533	267	5.0	7.3
3SH	0.032	588	294	13.0	16.5
Alclad 17ST	0.032	910	455	6.0	7.7
17ST	0.064	1373	687	11.5	17.5
43SH	0.064	1079	540	11.0	6.7
51SW	0.064	1076	538	13.2	14.0
24ST	0.064	1738	869	9.5	10.0

Each of the values in the above table was obtained on 1-in.-wide test specimens with a 1¾-in. lap joint as shown in the sketch at the right, and represents the average of five duplicate specimens.



any surface cleaning between the sheets or between the electrodes and the sheets.

The strong alloys are generally spot welded after receiving heat treatment. If this is done by bringing them up to temperature in a nitrate bath, a heavy, low-conducting oxide is formed. In general, this must be removed on the outside surfaces, where the electrodes contact the sheets, to prevent heating or melting at this point and consequent alloying of the sheet with the electrode. Also, in some cases it has been found desirable to clean one of the welding surfaces, but in no case is it necessary to clean both of these.

If the strong alloy has received its heat treatment by being raised to temperature in an air furnace, this heavy oxide is not present to a great degree, and probably no cleaning will be required either between the sheets or in contact with the electrodes.

The accompanying table gives a typical set of test values of a group of spot-weld specimens made up as shown.

Equipment and Methods for Seam Welding

Nearly every feature with respect to pressure, power control, thermal conductivity, oxide film, etc., mentioned in connection with spot welding, applies to seam or line welding.

The conventional machine consists of a pair of electrode rollers, one of which is motor-driven.

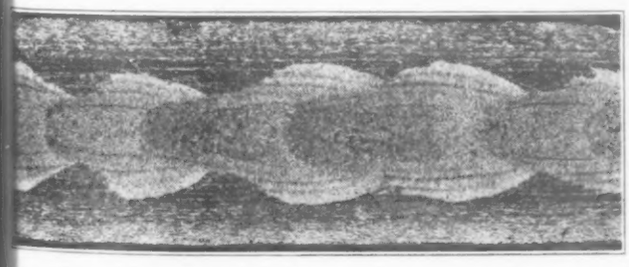
If a normal or continuous supply of alternating current is applied to the rollers, which are rotating under pressure on the sheets to be welded, immediate and complete melting of the sheets throughout will occur if sufficient power is used to make a weld at all. The high thermal conductivity of the aluminum alloys is primarily responsible for this result and, therefore, interrupted power is not merely desirable, but is absolutely essential.

However, a mere interrupted power supply alone is not sufficient. It must be synchronous so that each shot of power is an exact duplicate of the others, and these shots must represent a small proportion of the total time. With power on over half the time, seam welding is impossible and, in general, is unsatisfactory if power is on over one-third of the time.

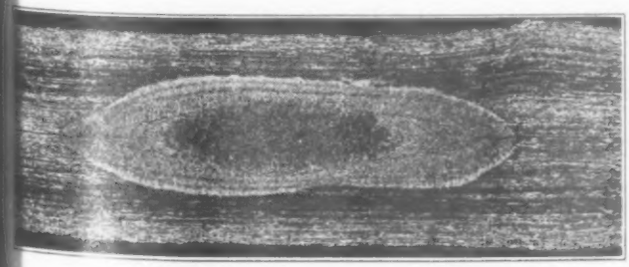
Most of our seam welding is done with

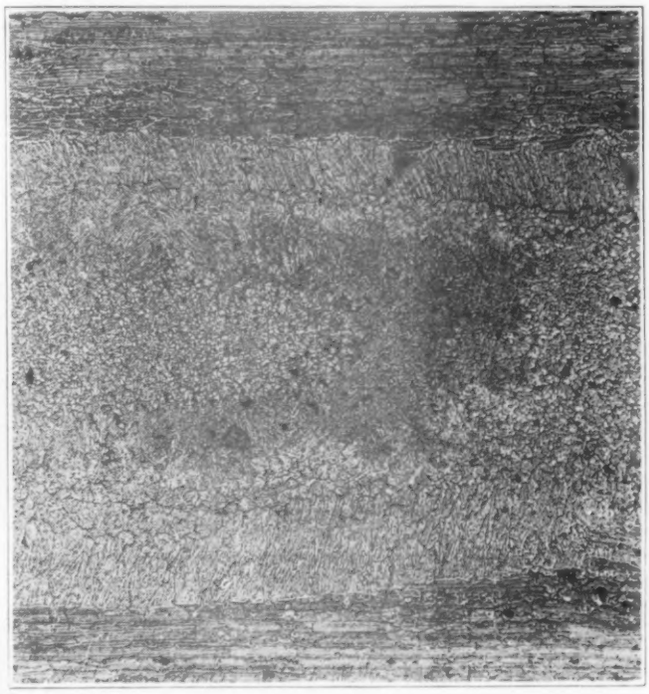
Fig. 3. Micrographs of a Gas-Tight Seam Weld of 53SW Aluminum Alloy Sheet of .051-In. Thickness.

Electrical adjustment made to give one cycle on and three cycles off.



Longitudinal view (above) and transverse section (below) of same weld. Reproduction, 25 diameters (or one-half actual magnification of original photomicrographs).





Reproduction, 50 diameters. (Magnification of original photomicrograph was 100 diameters.) Illustrates in greater detail a section through a portion of the cast zone shown in the micrograph at the left. The sheet near the top and bottom of the micrograph has not been heated sufficiently to cause reversion to the cast structure, but some incipient melting has occurred at the grain boundaries, which appear somewhat heavier than those in normal 51SW. The section through the cast zone suggests, in some ways, a section through a miniature ingot. The solidification evidently progressed from the edges toward the center of the cast zone. The columnar grains near the upper and lower edges of this zone were probably the first to solidify from the completely molten metal.

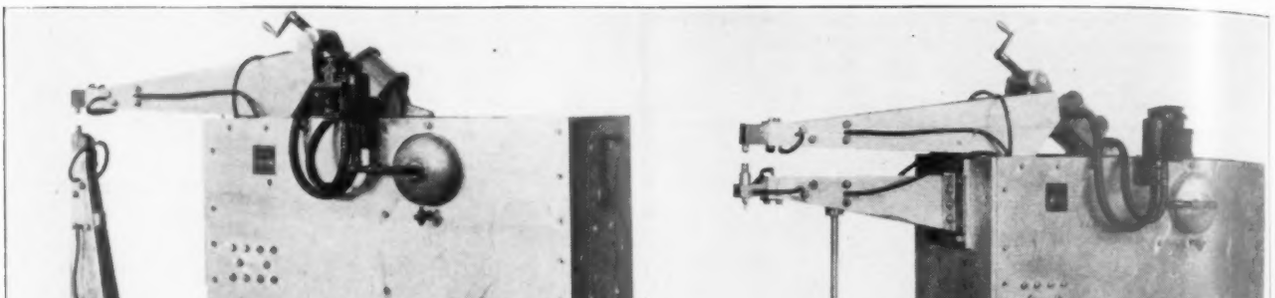


Fig. 4. Special Aluminum Spot Welders, 200 Kva., With 36-In. Throat.

one cycle on and three off, or two cycles on and six off. When sufficient power is available, these "on" percentages may even be decreased and provide a steeper thermal gradient from the weld to the outside surface.

There are several forms of interrupted power available, but all of our experimental work has been done with the thyratron control equipment, which has permitted almost any desired flexibility so necessary for development work with different gages and alloys.

Little or no trouble is experienced when the proper adjustments are completed in making gas- or liquid-tight seams in this manner with the alloys which are normally used for this type of work. It might be thought that the greatest field for seam welding would be for such purposes, and it will undoubtedly be used for many types of aluminum containers in the immediate future.

Spacing of Spots Permits Higher Strength

The field of seam welding is, we believe, much broader than this. It is a most excellent production tool for joining sheets mechanically where gas-tightness is not necessary, but where mechanical characteristics govern. It is obvious that a continuous gas-tight seam produces a cast structure continuously at the point of weld, as well as some annealing adjacent to the cast structure. This is not fully desirable where only mechanical characteristics are desired, and by properly proportioning the power impulses the seam will consist of separated spots.

Incidentally, with a given machine this type of joint will permit about double the thickness of sheet to be welded with the same welding amperes used to weld a gas-tight seam. This is because the spacing of the spots is wide enough so that the previously completed spot shunts the weld being made by a much smaller percentage of the available current than is the case with a continuous seam.

Fig. 3 shows micrographs of a continuous gas-tight seam in 53SW. The extremely high thermal gradient is shown by the apparently unaffected surface metal with the molten weld only a few hundredths of an inch away. For these reasons, when the setup is properly made, electrode maintenance is entirely negligible, as the outside sheet temperature (where it contacts the electrode) is so low that no trouble whatever is experienced with the electrode wheels picking up aluminum.

Where resistance welding is considered for the fabrication of aluminum products, either for gas-tight or liquid-tight containers, or where purely mechanical properties are needed, we feel that the design should be made, wherever possible, to use seam welding. It will be necessary of course to use spot welding where the mechanical limitations do not permit the use of a seam welder. Any mechanical joint, however, which can be made either way will unquestionably be much less expensive in production if the seam welder is used instead of the spot welder. In most cases the members can be designed to permit all or most of the joints to be made with the seam welder, using the spot welder, or possibly rivets, for such places as are not readily adaptable to seam welding.

Machines of High Rating Required for Butt Welding

Butt welding differs considerably from spot or seam welding in that usually the sections are heavier and the distance from the electrodes to the point of weld is greater, so that a lesser thermal gradient is necessary. It may be said to be the simplest form of resistance welding for aluminum alloy. It differs very little from steel practice, the main difference being that the normal design of a steel butt welder is considerably underpowered electrically, compared with its mechanical proportions, while a machine designed primarily for butt welding aluminum should have an electrical rating several times that which its mechanical design would normally indicate for steel.

The general method is to clamp the two sections to be welded in the electrodes and apply a pressure, preferably air, of about 1000 lb. per sq. in. of cross-section. A limit switch is adjusted to open the controlling contactors after a given travel. Fixed time has not been employed successfully; and, since the time

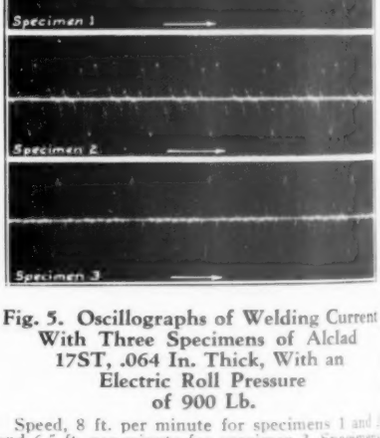


Fig. 5. Oscillographs of Welding Current With Three Specimens of Alclad 17ST, .064 In. Thick, With an Electric Roll Pressure of 900 Lb.

Speed, 8 ft. per minute for specimens 1 and 2 and 6.5 ft. per minute for specimen 3. Specimens 1 and 2, 22400 r.m.s. amperes, computed from primary amperes; specimen 3, 27000 r.m.s. amperes. These oscillographs show that for specimen 1 the welding current was on 4 cycles and off 16 cycles, for specimen 2 the current was on 1 cycle and off 3 cycles, and for specimen 3 the current was on 1 cycle and off 4 cycles.

of weld may vary from a fraction of a second to six or eight seconds in the heavier sections, synchronous control is of no importance.

Since heavy power is required, normally about 30,000 amperes per sq. in. of section, an excellent mechanical fit is necessary at the butted ends to prevent an explosion and arcing when the power is turned on. When all adjustments are made, the contactors are closed. They open automatically after a predetermined travel, a flash being formed all around

the weld. If everything works properly, there should be no fire or disturbance of any sort.

With a good butt weld most of the oxide film will be pushed out in the flash, and a reasonably non-porous structure will result with most alloys. Strengths of 80% of the original metal have been obtained with welds made in duralumin before heat treatment, the heat treatment being given after welding.

The question of butt welding involves so many different sections that it is difficult to discuss it except in a very general manner. The matter of electrode distance—that is, the amount of unsupported metal projecting from each electrode—is a compromise. The longer this distance, the less power required, and the better current distribution obtained. This is limited however to the mechanical strength of the metal adjacent to the weld, and this consideration limits the maximum distance with any given section. With extremely small sections of, say, 0.2 sq. in., distances of ⅛ in. to ¼ in. have been found satisfactory; whereas, distances as much as 2 in. have been used with sections of 3 sq. in.

Butt Welding of Simple Sections Offers No Difficulty

No trouble at all is experienced in welding simple sections, such as squares, rounds, or rectangles having not too great a ratio between breadth and width. When this ratio exceeds about 10:1, the problem of current distribution becomes difficult, involving very careful electrode design. Similarly, with complicated sections, such as many of the aluminum extruded shapes, the problem of electrode design becomes paramount and may involve preliminary experimenting and alterations before successful results are obtained.

Many variations of flash welding similar to that used for steel have been tried, but with very slight success. The general result is a rapid burning away of aluminum without obtaining a sufficient kilowatt input and consequent welding temperature to permit a good weld. The presence of oxides is also detrimental with this method, but experiments in inert gases would not apparently solve the flash welding problem.

This discussion has of necessity been quite general, as ratings of welding equipment are not highly standardized, and the proper settings to do a given type of work must be a result of cut-and-try methods within certain limits.

Consistent results however are, in general, to be expected where the material used for a given job does not vary in its rolling, heat treat, and forming methods. Obviously, all check welds should be made with the identical material used in production.

Get "*H. O. T.*" on Welding

■ Edited by
H. O. T. RIDLON
Welding Consultant, Joliet, Ill.

[This section is dedicated to Better Welding and Better Welding Shops. Suggestions and criticisms are invited.]

We Acknowledge With Thanks—

Thanks, youse guys, yes sir! for all the mail, comments, discussions (and cussing) on the first column, so help me! I'll get around to a personal reply sometime. But now I'm busy, for sure enough the well known "corner" seems to have been turned, and so—I say please forgive me! Keep the mail a'coming! Thanks, my good friends.

Buy Your Welding Machines, Don't Try to Build Them

Many of you shop owners and welders have written in wanting a layout for building up your own A.C. and D.C. outfits. Sure you can do it, perhaps! But, there are some things about it that should be said. And things that you should carefully read, study and inwardly digest—because they came from a heap of experience (mostly sad).

Perhaps it's because of my New England ancestry that the easiest place to hurt me is in my pocket book. But, maybe some of you fellows have rich papas or that "biz" is so darn good that you can afford to dump profits out the door. But something tells me to doubt it, 'cause it's not reasonable that anyone wants unsatisfactory results, extra work and money thrown out. It's an urge to get into electric welding, or more welding, and make money that brings to you this hope of saving money, so let's sit down and think this thing through.

It seems only a few years ago that big companies like Westinghouse, Una, G. E., Lincoln, and others put on the market welding machines that could stand a lot of improvements, as has been proven by the machines they are offering today; and, no doubt, those companies and others will continue to make improvements in their outfits. Perhaps they won't, but here's hoping they do. 'Cause it still sort of looks as though maybe some improvements could yet be made. Don't get me wrong. I don't think I'm so hot I can improve on them, but I might make a suggestion to one or two on this or that.

But here's the thought I would like to get over to you: These companies have money (and it takes lots of it) and men with brains, trained to carry on these experiments—so it's downright folly for a shop owner to try to build his own welding equipment. Companies better equipped to do it than a small shop—yes, even a big shop—don't do it, because it's a waste of time and money. Each man to his job—you welding-shop owners and welders, keep on welding. Improve your skill, spend your time selling welding and fixing up your shop. Keep it clean and up-to-date. And soon, maybe, you'll find if you run your business right, you'll be able to buy a modern machine from a reputable firm, suitable for the work you demand of it, and make a profit on your investment.

And All Stayed Till the Meeting Closed at Midnight

Gee, what a swell meeting the A. W. S. had in "Chi" last month. What a night! What a gathering—what talent! Seems as though there was a bit of difference of opinion about the boiler code, stress-relieving high-pressure vessels, gamma-rays, X-rays and what have you. The Big Boys played with charts—beautiful things. It's swell for us of the rank and file to bask in such brilliance, get slapped about by slide-rules and splash our bodies with the wisdom of the mighty. But our job is greater (as most simple things are), which is to improve our skill and ability as welders, so that after we've finished a job, and say "Mister, that's really grown together," the one we say it to will know that it is really welded, Class A1 work, and no fooling.

Here's the Dope on Arc Welding Chilled Cast Iron

On welding chilled cast iron with the arc, for my friends who ask, sure it's been done successfully. How? By careful V'ing and using an abundance of studs, welding the parts together with a good mild-steel rod, then a layer of high carbon, and then finishing the top surface with a good hard-facing rod suitable for your job, such as Stoody. (Other manufacturers, please forgive, this is not an ad.) And, finally, here is a "tip" that I'll repeat often and loud, 'cause sometimes in your hurry to get a thin dime to buy a soup bone with, you neglect it: Take time to clean and prepare for your weld correctly, and, take it from old "Hot," if you don't, you're going to pay.

The Latch Is Out to World's Fair Visitors

There's lots of welding being done at the World's Fair in Chicago. Perhaps you'll be coming to see the wonders of the world. If so, stop in and say "howdy."

Mr. Piccard, the Author of This Article, Is Holding a Segment of Dowmetal Plate of the Same Size and Shape as Those Used to Form the Gondola Shown in the Background.

AN ASCENT into the upper regions of the earth's atmosphere, known as the stratosphere, will be made from the grounds of A Century of Progress, in Chicago, on July 1st or as soon thereafter as atmospheric conditions will permit. Delicate instruments will be carried to determine the direction and intensity of the cosmic rays and to photograph the solar spectrum. The flight will be made by Dr. Jean Piccard and Lieutenant-Commander Settle, of the U. S. Navy, who will attempt to reach a height of 12 miles above sea level.

Construction of Welded Gondolas for Stratospheric Balloons

■ By DR. JEAN PICCARD

FOUR main factors have to be considered in the design of the spherical basket, or gondola, for use with stratospheric balloons. These are light weight, air-tightness, tensile strength, and resistance to deformation. With these four factors in mind, it was but natural that the possibility of using lightweight metals or alloys, with all seams welded, should be investigated. Because of the importance of welding to the solution of this problem, I was glad to accede to the request of THE WELDING ENGINEER to submit the following information for the benefit of its readers.

Before my brother, Professor Auguste Piccard, made his first flight into the stratosphere, he considered steel, duralumin and aluminum as possible materials from which to construct the gondola.

Welding Makes an Air-Tight Joint Having Eighty-Five to Ninety Per Cent Efficiency.

The walls of a steel gondola would, of course, be much thinner than those of an aluminum gondola.

The most important strain to which the walls of a stratospheric gondola are subjected is produced by the inside pressure of nearly 14 lb. per sq. in. while the outside pressure is only 1.4 lb. per sq. in. This requires a material of good tensile strength. For equal weight, there is not much difference in tensile strength between duralumin and steel.

The next most important requirement for a stratospheric gondola is perfect air-tightness. For this reason Professor Piccard decided to use welded metal.

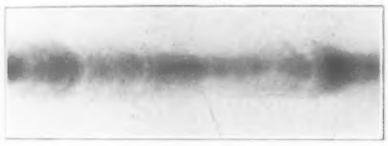
Must Be Rigid Enough to Withstand Accidental Blows

Steel, in order to be light enough, would have to be very thin. The gondola must not only withstand the near-vacuum of the stratosphere. It must also, on the ground, offer a reasonable resistance against accidental blows and against local pressure, such as the strain produced by a man standing on it. Here light metal of equal tensile strength per unit of weight has an enormous advantage over steel, because the resistance against bending increases with the second power of the thickness. Therefore, if two gondolas of equal weight, one made of steel and the other of light metal, had equal value once in the stratosphere, the latter would be preferable on account of its advantages on the ground.

Duralumin has the disadvantage of losing some of its qualities by being

welded. For this reason my brother chose the softer, pure aluminum for his gondola. This metal is very good for welding. It stands a lot of deformation without breaking and, indeed, the gondola used in his first flight proved quite successful. For the second flight, he again chose pure aluminum. [The gondola used by Professor Piccard on his second flight is on exhibit in the main hall in the Science Building at A Century of Progress.—Editor.]

When my brother was asked to prepare a flight from Chicago under the sponsorship of A Century of Progress, the *Chicago Daily News,* and the National Broadcasting Co., the question arose again as to what kind of metal should be used for the new gondola. There was no doubt that aluminum could again be used. On the other hand, since it was preferable to build the gondola in the United States, we were given the opportunity of going one step further in the direction of lighter metals. We investigated the possibility of using Dowmetal. The various kinds of commercial Dowmetal are alloys containing about 95% magnesium. The density of these alloys is about 1.8, or 33% less than pure aluminum (density 2.7). Dowmetal has the



X-Ray Image of Welded Seam of Dowmetal Gondola.

same advantages over magnesium that duralumin has over aluminum, but in addition it has the great advantage of not being weakened by welding.

New Gondola Is One-Third Lighter Than Old One

The Dow Chemical Co. is furnishing the Dowmetal gondola and in addition is making the desired experiments to test the value of this material for this particular application. Dowmetal being considerably stronger than aluminum, we did not need to increase the thickness of the walls of the new gondola, and for this reason we can take full advantage of the lighter weight of Dowmetal. The shell of the new gondola will actually be one-third lighter than the old aluminum gondola, and this means something for a stratospheric flight where each and every pound of material has to be lifted by 175 cu. ft. of hydrogen.

The welded seams of the Dowmetal gondola were not peened. While hammering may increase the strength of the welds themselves, it decreases the resistance of the neighboring metal and, as a whole, it was thought it would do more harm than good. The reinforcement was removed from all welds, and the welds and adjacent metal ground smooth. Nevertheless, the welded seams of the gondola have lost very little of their original strength. The tensile strength of the weld, found experimentally, was actually 90% of the original strength of the Dowmetal plates.

The spherical shell constituting the gondola has a diameter of 7 ft. and a thickness of 3.5 mm. (0.138 in.), and weighs only 192 lb.

No Fear of "Perils of the Stratosphere"

By means of the tensile strength coefficient, and assuming 80% as the efficiency of the welded joints, I calculated the strength of the sphere and found that it would hold 13 atmospheres inside (191 lb. per sq. in.) while being in an absolute vacuum. At first I did not trust my calculations and I computed the figures in another way, but the result was the same. Enclosed in such a shell, one does not need much courage to trust his life to "the perils of the stratosphere."

In addition to the shell and the doors, all the interior of the gondola (floor, shelves, supporting struts) as well as part of the instruments are of welded Dowmetal construction.

Demonstrates Portable X-Ray Machine

Unusually interesting and unique features marked the meeting of the Los Angeles Section of the American Welding Society held on the evening of May 18th in the Chamber of Commerce Building. The meeting was in charge of Chairman Ben M. Laulhere, and was preceded by an enjoyable old-fashioned "Dutch Lunch" with "real beer." Approximately 410 members and guests were present. The meeting was held under the joint sponsorship of the American Welding Society and the American Society for Steel Treating.

The first of the two main features of the meeting was an interesting motion picture film entitled, "The Eyes of Science," which was shown through the courtesy of the Bausch & Lomb Optical Co. of Los Angeles. George Rhode, representing the optical company, gave interesting comments and explanations as the picture was shown. Demonstrations were given of a toolmaker's microscope and a polarized-light microscope.

A paper entitled "The X-Ray in the Field of Welding," prepared by Russel J. Love and J. W. Capek, of the Industrial X-Ray Corp., of Los Angeles, was read by Mr. Love. This interesting paper described various uses for the X-ray in welding and its many applications in testing materials and welded construction.

Mr. Love's paper was followed by a motion picture and slides showing radiographs of good and bad welds, illustrating flaws. These radiographs were discussed by a representative from the N. V. Philips Gloeilampenfabrieken, of Eindhoven, Holland, developers of the Philips "Metalix" portable X-ray apparatus, which the Industrial X-Ray Corp. are manufacturing and selling in the United States.

An actual demonstration followed of the newly developed portable X-ray apparatus. This demonstration comprised the radiographing of a block of wood, revealing spikes driven in from the under side, as well as a piston with an invisible crack (or one not noticeable to the naked eye) which was plainly visible under the X-ray. The portability of the equipment, allowing it to be taken directly to the object to be inspected, together with its high degree of accuracy, are worthy features of the machine, which may lead to a new era in American manufacturing methods.

Plans Going Forward for National Metal Congress

The National Metal Congress and Exposition will be held in Convention Hall, Detroit, Mich., October 2nd to 6th. During this week the American Welding Society will also hold its fall meeting in Detroit. The Exposition is held under the auspices of the American Society for Steel Treating. In view of the leadership of the automobile industry in the consumption of steel at the present time, the selection of Detroit in which to hold this exposition is significant. Advance reservations for space are coming in at a satisfactory rate, reports W. H. Eisenman, Secretary, 7016 Euclid Ave., Cleveland, Ohio.

Chicago Power Show to Be Held at Stevens Hotel

The Sixth Midwest Engineering & Power Exposition will be held at the Stevens Hotel, Chicago, June 27th to 29th, which is "Engineering Week" at A Century of Progress. This exposition portrays the latest type of engineering equipment and improvements in the field of power engineering. There will be shown pertinent plant equipment ranging from thermostats to complete water-softening systems, and many displays will be in operating form.

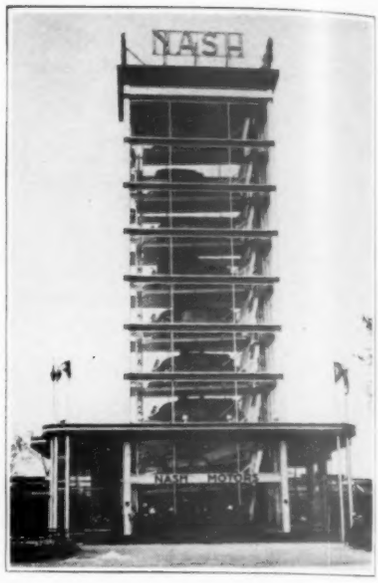
Death of J. W. Bettendorf

With the death of J. W. Bettendorf, president of the Bettendorf Co., Bettendorf, Iowa, on May 16th, the Tri-Cities district lost one of their foremost citizens. Mr. Bettendorf was also president of the following firms: Zimmerman Steel Co., Micro Corp., Westco Pump Co., and Buddy L Manufacturing Co., all of the Tri-Cities.

Skillful design and neat workmanship in the use of the cutting torch and welding arc are evident in the

Whiting Parking Tower . . .

at "A Century of Progress" Exposition

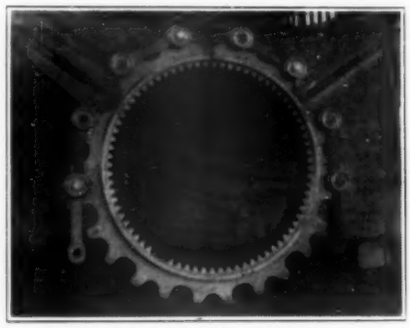


ONE of the outstanding exhibits at A Century of Progress Exposition is the Nash Whiting Tower, in which welding and gas cutting were used to economic advantage. To a Whiting engineer, J. E. Morton, inventor of this modern parking system, belongs the distinction of having designed and built the first parking machine. This, the first machine of its kind ever built, has operated very successfully in continuous service for more than four years.

Sixteen beautiful Nash models are on display within an 80-ft. glass-enclosed Whiting parking tower located immediately south of the Travel and Transport building.

The mechanism of this unit is designed for 32-car capacity. At the close of the Century of Progress Exposition, this unit will be applied to regular parking service occupying approximately 16x23 ft. of ground space.

The procedure for parking service is as follows: The car is driven onto its individual parking platform, where it remains completely protected against all possible damage and where parcels may be locked inside the car if desired. The owner receives a claim check; the entire parking operation being accomplished with almost the same ease as checking a hat.



Torch-Cut Sprocket Welded to Cast-Steel Gear.

When calling for his car, the car owner hands his claim check to the attendant. The attendant presses an automatic selector button, and instantly the selected car, together with its individual parking platform, starts down (over the shortest route) to the exit level. The car is ready to be driven away as soon as the parking charge has been paid. Where desirable, as in apartment buildings, each car owner operates the machine—a key for each individual parking space being provided.

The machinery is standard, whether erected in building hatchways for use in connection with hotels, office buildings, apartment buildings, department stores and garages, or erected in outside parking service in skeleton steel towers as in the case of parking-lot service.

The machines are easily moved from one location to another, and their erection requires no great accuracy of alignment for satisfactory operation.

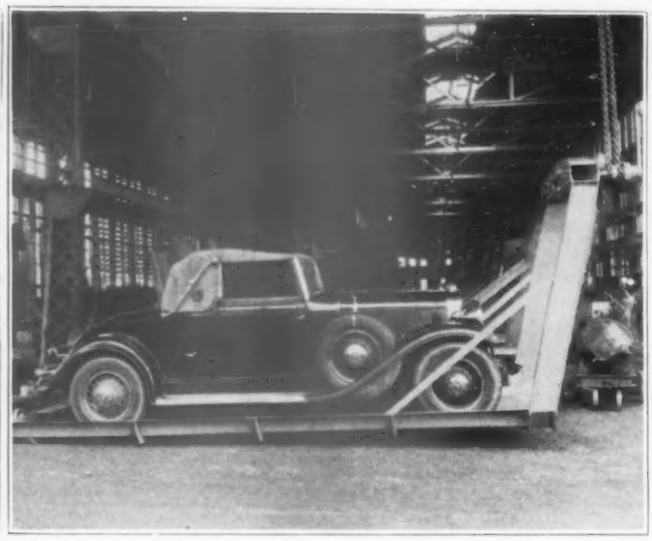
Essentially, each parking tower is a vertical conveyor or double elevator. Endless chains support the individual parking platforms, which are movable in either direction.

Large flanged forged steel chain rollers are used for carrying the load in a manner similar to the flanged wheels of a railroad train operating over rails. The industrial rails used for chain tracks are straight in the intermediate sections of the tower and are attached directly to perfect half circle tracks at both top and bottom.

At the bottom of the tower, two combination ring gears and sprockets are used for driving the two elevating chains. A drive shaft with pinions mounted at each end and meshing with the internal ring gears insures the same speed for both chains.

The mechanism of this machine is in large part cut by automatic cutting machines and welded by the metallic-arc process. The platforms are of all-welded steel construction, utilizing plate and standard steel shapes. The weight of these platforms is held to the minimum by the use of metallic-arc welding. All chain links were cut out of 1⅛-in. steel

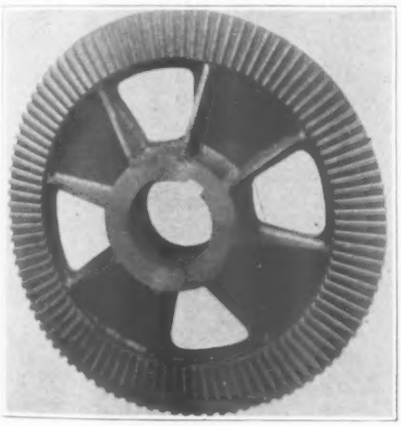
A Total of 192 Small Links and 64 Large Links Were Cut From 1⅛-In., .35-.45 Carbon Plate for the 16-Platform Machine.



The Machine Is Now Equipped With 16 of These Platforms and 16 More Will Be Added Later.

plate by the use of an automatic shape-cutting machine.

The two combination ring gears and sprockets were also welded. The 26 teeth in each sprocket were cut out by means of the oxyacetylene shape cutting machine. These sprocket gears are 100 in. in diameter and weigh 3500 lb. each. They are constructed of a ring steel casting with the sprocket of steel plate welded on the outside. No machine work



All-Welded Driving Gear, in Which the Gear Itself Was Cut From a 2-In. Plate by Means of a Torch.

is required on the teeth of these sprockets. The torch cut is quite smooth and requires but very little hand grinding.

The bevel drive gear is also cut out of steel plate and welded, making a very neat as well as durable and dependable gear.

The welding on this job was conducted under the procedure control which has been in use at the Harvey, Ill., plant of the Whiting Corporation for several years.

Each operator stamps each part welded with his individual stamp or symbol. All welds are carefully inspected for workmanship and appearance as the welding progresses. These measures place individual responsibility upon each welding operator and tend to promote the making of sound, reliable welds.

Welding Demonstrations at Rosenwald Museum

Several interesting demonstrations in the welding and cutting field can be seen at the Rosenwald Industrial Museum, in Jackson Park, Chicago, which will open its doors to the public on July 1st. Among these demonstrations is one of underwater cutting of metals with an oxyacetylene torch, actual arc welding of various metals in a welding booth, welding of metal strips in a spot welding machine, and displays of welds in ferrous and non-ferrous metals and alloys.

Welding Meeting for Engineering Week

Engineers visiting Chicago during Engineering Week (June 26th to July 1st), particularly members of the American Welding Society, are invited to attend a meeting on welding to be held under the auspices of the Chicago Section of the American Welding Society in the air-cooled Joseph Urban Room in the Congress Hotel, on Thursday, June 29th, beginning at 10 a. m. Two papers pertaining especially to the application of the welding and allied processes at A Century of Progress will be read, followed by a dinner and a round-table discussion. Many points of interest in the field of welded construction that might be overlooked by the visitor at the Fair will be brought out, and the discussion will allow every one an opportunity to bring up questions of procedure, design, and economies in the application of welding processes. Dinner will be $1.50 per plate, and will be served in the Joseph Urban Room following the papers program.

Design and construction of the two massive Sky-Ride towers will be discussed in a paper by A. L. Wilson, of the Mississippi Valley Structural Steel Co., with particular reference made to economies of welded fabrication and the procedure employed.

Many other interesting applications of the welding, flame cutting and allied processes in evidence at the Fair will be covered in a paper by J. M. Jardine, of the Western Welding & Boiler Repair Co., which will include detailed descriptions of outstanding welded fabrication.

Chicago Code Does Not Apply to World's Fair

The builders of the structures at Chicago's Exposition, A Century of Progress, were not limited by the present Chicago building code, since the exposition grounds are in Burnham Park, which is under the jurisdiction of the South Parks Board and of the State of Illinois and not of the City of Chicago. A building code was developed by the South Parks Board to cover the erection of structures at A Century of Progress, and it was under this code that welding was introduced into some of the structural work.

Though hearings on the proposed new Chicago code have been temporarily abandonded, the citizens' committee of architects and engineers are continuing their meetings, and it is thought in some quarters that hearings by the city council committee will be resumed early in the fall. At the very earliest, it will be some time after the close of the present year before the code can come up for final consideration before the common council, but progress is being made as rapidly as circumstances will permit. No opposition has yet developed to the structural-welding provisions in the code, though some differences of opinion are evident as affecting certain other parts.

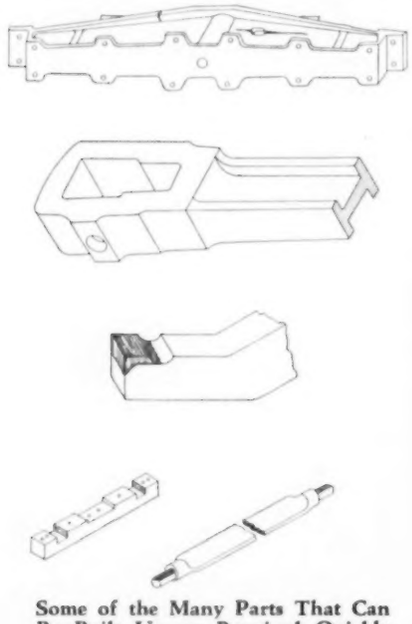
Shielded-Arc Welding in Railroad Shops—II

Second of Two Articles

■ By W. B. HORTON
The Lincoln Electric Company

IN THE railroad machine shop, a large portion of the mild-steel welding work is the building up of worn surfaces as shown in the accompanying drawing. This type of work requires electrodes of high tensile strength and ductility, high speed of deposit, and easy machinability, The latter is extremely important. Mechanical officials are often deluded into the belief that their welding costs are low, because they are splashing metal on worn castings at a great rate, and therefore they show up extremely well as far as direct welding cost in concerned. As a matter of fact, when the welds are passed on for machining and are found full of hard spots and holes, with poor fusion between the weld metal and the parent metal, the damage to tools and lost time of machine hands, plus the rejects, raise the ultimate repair cost alarmingly.

Welds made in a shielded arc possess the characteristics of homogeneity and absence of hard spots. Having absorbed no oxygen or nitrogen during the welding operation, they are free of impurities



Some of the Many Parts That Can Be Built Up or Repaired Quickly and Cheaply by Shielded-Arc Welding.

and therefore machine with the same ease as mild-steel plate.

Another great advantage in build-up work is the great speed of deposit obtainable with the shielded arc. With the same size of electrodes, it is 1½ to 2 times faster than ordinary bare or light-coated rods. In addition, on jobs where there is a fairly large surface area to be built up (crosshead guides, for example), electrodes as large as 5/16 or ⅜ in. can be used, and the total welding time consumed is only about one-third that needed for the smaller size of the ordinary electrode.

Build-Up Jobs in the Machine Shop

On many machine-shop build-up jobs large economies can be effected by shielded-arc welding. Some of these are listed below, together with recommended electrode sizes. It should be understood that any smaller electrode will do the job equally well, but the sizes designated are those that will produce the highest speed, and are therefore the cheapest to use:

Cross-head guides	¼ to ⅜ in.
Driving-box surfaces	5/16 to ⅜ in.
Link action and parts surfaces	3/16 to 5/16 in.
Shafts	5/32 to ¼ in.
Binders	5/32 to 3/16 in.
Cams	⅛ to 3/16 in.
Coupler parts	⅛ to ¼ in.
Guide bars	3/16 to ¼ in.
Other applications	⅛ to ⅜ in.

Another important section of machine-shop welding is the filling up of holes, which may or may not afterward have to be drilled out again. In case the hole does not have to be redrilled, and the object of filling it up is merely to add to the mass and therefore the strength of the casting, the quality of the weld metal is not of paramount importance. In such cases, ⅜-in. electrodes, adding small stampings or pieces of scrap in the hole, will yield results that are almost unbelievable.

However, holes that have worn out of true, and are to be redrilled and used again, present a different problem. Here again a large electrode (5/16 or ⅜ in.) may be used, but metal scrap should be very sparingly employed; it is essential that the latter be clean and of good quality, and that it be completely melted. In such welds, the best quality of weld metal is needed, so that high-speed tools are not damaged in re-opening the holes, and so that the holes retain their character as long as possible in service. Good speed will be secured by the use of 5/16-in. electrodes and the subsequent drilling will disclose metal as workable as the best mild steel. Such applications are too numerous to enumerate individually. Suffice it to say that any small hole, up to 2 in., in any mild-steel part or casting, may be filled up at a low cost, and with absolute confidence that there will be no difficulty in drilling out the new hole. With good

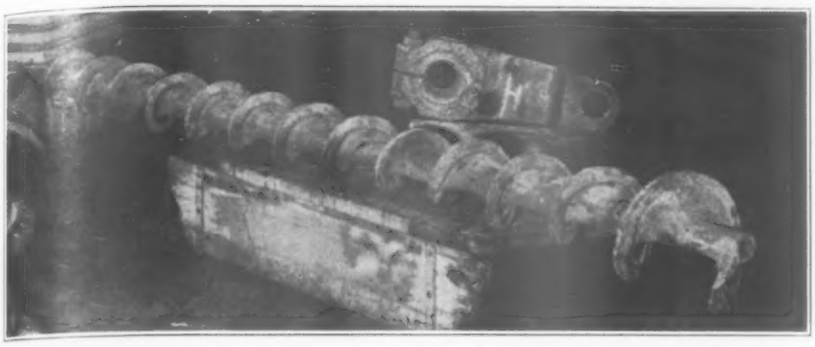
Only 11 Minutes Was Required to Build Up This Driving Box and Frame Shoes. The Welds Are Shown Before Machining.

fusion between the parent metal and the shielded-arc weld metal, no difficulty will be encountered even if the new hole is not drilled directly where the old one was.

Another common application of building-up is that of large holes worn out of shape. Such holes are those in which a shaft or bar or part hangs or works. They are from 2 in. up to 8 or 10 in. in diameter, and include those which are too large to be re-drilled. These holes are not filled up, but must be built up on the inside surface and then tooled to size. Oftentimes such surfaces are very difficult of access, and it is much easier for the welder to work with heavily coated electrodes as these will not "short" against the edges of the hole as ordinary electrodes do. Again, the re-working of the hole to size is facilitated by the good quality of the weld metal.

Repair of Automatic Stokers on Locomotives

With the adoption of automatic stoking rapidly becoming universal on American coal-burning locomotives, the repair of the parts of automatic stokers has become a major welding operation. The very nature of the work they perform and the material they handle make these stokers wear away quickly, and thus they demand frequent repairs. The evident economy of restoring their parts by welding, rather than by buying new ones, makes this a standard railroad welding job. The use of the process in the rebuilding of abrasion-worn conveyors, screws and crushers results in material savings. Either with or without the use of steel plate in restoring the screw to size, this method of repair is the most enduring and economical.



Automatic Stoker Screw and Crank Linkage Before Machining. Welding Time Was Cut in Half by Using the Shielded-Arc Process.

Frame welds on either horizontal or vertical members can be completed in an average time of 4½ hours with one operator. Where it is possible to put two men at work, the job can be done in two hours' time. This represents a very large saving as compared with any other method of welding. It is not necessary to use any reinforcement with this process as the toughness, ductility and tensile strength of the weld metal is always at least as great as that of the parent metal. When welding a horizontal member, however, the operator will find it advantageous to place a plate across the bottom of the fracture, the effect being greater speed and an easier task of welding.

Preparing Frame Sections for Welding

Preparation for frame-section welding is substantially the same as for other methods. If possible, the member is double-V'd out with an angle of 60° across each V (see *a* in the accompanying sketch). If the double-V is not practicable, a single-V may be used, in which case the cut should be bellied out as shown at *b*. It is always best, where possible, to make frame welds from the top, but of course this is practicable only in a limited number of cases.

The portion to be welded is cut out to shape and any burned metal inside removed. The kerf should be carefully cleaned, with a sand blast if possible. The edges are fitted as hereinafter outlined. If the locomotive is wheeled, the frame should be supported at the point of weld so as to relieve it of strain. To provide for contraction, the member should be forced apart ⅛ in., and then a wedge driven into the gap on the side farthest away from the point at which welding commences. The gap should now be ⅛ in. where the welding starts, tapering up to 3/16 in. where the wedge is inserted. Referring to diagrams *a* and *b*, the distance at *A* is 3/16 in., and the distance at *B* ⅛ in., while the wedge is inserted at *A*.

Sketch *c* shows the type of V to be used on horizontal members accessible only from the top, and *d* shows the procedure for vertical members.

The illustrations also show a plate placed across the bottom of the member to facilitate the welding operation. In the case of a vertical member, the illustration would be turned sideways.

Welding starts with 3/16-in. electrodes at point *B*. Great care should be taken to secure good penetration and fusion at the seam. After each layer is deposited, the weld metal should be thoroughly cleaned with a scratch brush, and peened with an air hammer and roughing tool. After a good, solid foundation of weld metal has been deposited with 3/16-in. electrode, ¼-in. or 5/16-in. may be used to speed up the work. When the weld is half completed, the wedge is removed. After the weld has been completed approximately flush with the sides of the member, a pad of weld metal should be deposited all around with 3/16-in. electrode, so that the weld is nowhere of smaller dimensions than the frame section. The finished weld should be thoroughly peened all over.

Building Up and Repairing Wheel Centers

The shielded-arc process is ideal for wheel center work. The face of the rim may be built up either automatically or manually. With the automatic shielded-arc process, 14 to 15 lb. of metal is deposited per hour. [Note that this is actual metal deposited and not the amount of electrode used.] This method offers tremendous economies where 150 sets or more per year are to be handled. Where a smaller number are going through, the manual process is very satisfactory and much faster than other hand welding. In either case, the resultant built-up metal is of good quality, free of hard spots, and easily machinable.

Cracked rims and spokes on cast steel wheel centers can be welded satisfactorily and economically. The cracks are V'd out and sand blasted, the spoke or rim wedged open at the fracture to provide for contraction, and the welding proceeds similarly as with a frame weld with 3/16-in. electrodes being used. Where the wheel center is cracked down into the hub between the spokes, it is important that the crack be opened up clear to its farthest extent and, for safety, ¼-in. beyond. The metal should be carefully cleaned and the opening welded up with a 3/16-in. electrode.

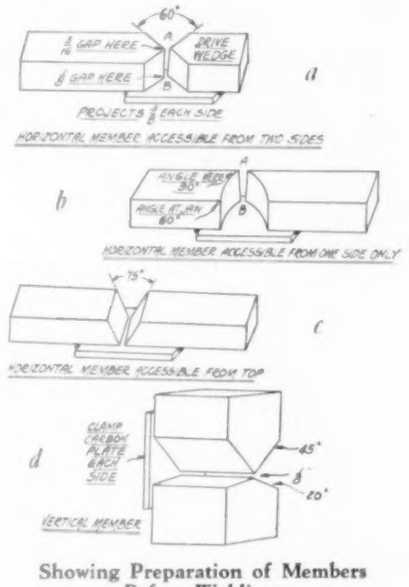
Damaged cabs built of riveted steel are quickly and economically repaired by arc welding.

Liner faces built up with 5/32-in. shielded-arc electrodes will machine easily and truly.

Organization for Welding in Railroad Shop Centers

The functional organization of individual railroad shop centers differs as far as welding is concerned. Some shops have an electric-welding department for repairing all parts small enough to be conveniently moved to the department, while controlling one or more portable machines that are sent around on call to be used on large units. This welding department is located usually in the machine shop, but occasionally in the blacksmith shop. Large railroad shop centers, however, have found it economical to decentralize the welding to a greater or less degree. The welding foreman will then be located usually with his main shop in the machine shop, while the other shops will each have one or more welding machines of their own, with each shop handling its own work.

Very large savings can be effected in



Showing Preparation of Members Before Welding.

the repair and upkeep of tools and equipment belonging to the railroad, through the use of portable electric-arc-welding machines. Any parts of tools and machines constructed of mild steel or wrought iron and broken, cracked, or worn down may be quickly and safely repaired or built-up.

The writer recalls one job recently where there was a large leak at the joint of a steam pipe in the power plant of a large railroad shop center. Originally a pinhole leak had developed. As it enlarged it had been caulked again and again until finally the leak had assumed

large proportions. The ordinary course would have been to shut down the boiler, allow it to cool, tear out the defective pipe and replace it. This would have meant a shutdown of at least 36 hours.

In this case the power-plant foreman asked the writer whether the repair could possibly be made by welding. He was informed that it could be done with the shielded-arc process in an hour and a half, and that it would not be necessary to shut down the boiler. A portable welding machine was taken to the power house, and even though the job was located in a very difficult position (the work was part vertical and part overhead, and the spot was hot, to say the least), it was completed in one hour and twenty minutes after welding commenced. The railroad's own operator, without previous experience with the process used, did the work. Of particular importance on this job was the fact that such welds are impervious to the corrosive effects of steam. The savings, of course, were tremendous.

Repairing Broken Shop Machines

If a crack or break happens to occur on a shop machine that is in constant use, it is most important that repair be made immediately. Such accidents are common on shears, hammers, etc. Where the broken or cracked part is of mild steel or wrought iron, the repair is quickly and easily made with the arc.

Should the break occur in a part constructed of high-carbon or alloy steel, or one surfaced with such material, the shielded-arc principle with high-carbon electrodes may be used.

An interesting instance occurred when the anvil die of a large drop hammer cracked through the surface in several places. This die was a 1100-lb. casting of mild steel with a 2-in. deep specially hardened surface. It was the only one in the shop, and the hammer was the only one available for forging large billets from scrap. At least 10 days would have been required to procure a new casting, and it was vital not to keep the hammer out of service for so long a period.

Our experience with the shielded-arc process tells us that it is applicable to even such a difficult assignment as this die. The procedure would be to prepare the casting by cutting out the cracks clear down to their bottom and cleaning them thoroughly. A 5/16-in. or 3/8-in. mild-steel heavily coated electrode would then be used to fill up the hole to within 2 in. of the top, and the deposited metal carefully cleaned and thoroughly peened. The top 2 in. would then be welded in with high-carbon electrode and the surface ground off flush. A new die would cost nearly $200. The cost of the entire repair job as outlined is less than $10, and the hammer would be out of service less than a day.

These illustrations, while showing tremendous savings, are only typical of the day in and day out economies that are available to railroad shops today. It is a startling statement, but nevertheless a true one, that a welding machine will in most cases save more than its cost in one year's time.

Arc Welder Saves Its Cost on One Job

It is a matter of record that in some cases such a machine has paid for itself on one single job. With modern welding technique, which removes entirely the weld-failure factor, these large economies possible with the electric-arc method certainly indicate its ultimate all-over adoption in efficient railroad shop centers.

It has sometimes been stated by high railroad mechanical officials that claims of possible economies through complete adoption of the electric-arc process are exaggerated; and that, even if the claims were true, the history of failures with this process would prevent such an adoption.

In refutation of these statements, it has actually been demonstrated that the appointment of an efficient welding supervisor has resulted in direct savings of $100,000 to $150,000 per year, besides other large but intangible savings. There are large railroads operating today that could save equivalent amounts through the installation of standardized and compulsory repair methods throughout their shop systems.

The giant strides recently made in the electric-welding art, through improvements in machines and the discovery of the shielded arc, have made it possible to obtain strong, sound welds with a reliability approaching perfection, thus increasing the value of arc welding to railroads and other industries.

A. S. T. M. Exhibit to Be Held Engineering Week

Special testing equipment developed by research laboratories and by committees of the American Society for Testing Materials will be featured in the second exhibit of testing apparatus and equipment to be held under the auspices of the A. S. T. M. at the Stevens Hotel, Chicago, June 26th to 30th. Manufacturers of testing and related equipment will exhibit and demonstrate new apparatus as well as improvements in the more standard types. Displays will include equipment for tests and studies of metals and of other engineering materials, as well as hardness-testing equipment, universal testing machines, fatigue testers and other instruments.

A. S. T. M. Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, as well as other committees, are planning to participate in the exhibit. These committees, together with research laboratories cooperating in this exhibit, will show apparatus and a method for corrosion testing by means of the acid and salt-spray solutions, a machine to test the soundness of welded pipe joints, an instrument that magnifies machined surfaces 2000 times, and other newly developed devices.

A. S. M. E. Code Is Aired at Meeting in Chicago

A discussion of the requirements of the A. S. M. E. Boiler Code, particularly as they relate to stress-relieving and X-raying, occupied the meeting of the Chicago Section, American Welding Society, held in the Florentine Room at the Congress Hotel on the evening of May 19th.

A number of distinguished men in the welding field were present at the meeting and either gave prepared talks or entered into the lengthy discussion. Dr. C. A. Adams was present as the official representative of the American Welding Society, New York. Speakers were E. R. Fish, of the Hartford Steam Boiler Inspection & Insurance Co.; Dr. H. H. Lester, of the Watertown Arsenal, Watertown, Mass.; and T. McLean Jasper, of the A. O. Smith Corp. These speakers, in their respective order, discoursed on the subjects of the formation and operation of the Code Committee, and the practical application and value of stress-relieving and X-raying.

E. B. McGuire, of the Hamler Boiler & Tank Co., Chicago, led the discussion of those opposing certain of these provisions in the boiler code, in the course of which particular criticism was made to the provision in paragraph U-76 requiring stress-relieving wherever the ratio of the diameter to the cube of the shell thickness is less than 100, as well as to certain other provisions pertaining to stress-relieving and X-raying. Among those entering the discussion were J. C. Hodge, of the Babcock & Wilcox Co., Robert Kincaid, of Cleveland, and Professors T. C. Huntley and A. H. Carpenter of the Armour Institute of Technology, Chicago.

Metal Coating is Topic at Philadelphia Meeting

Richard L. Binder, president of the Metal Coating Co. of America, Philadelphia, Pa., presented an illustrated address on "Metal Coating," at the meeting on May 15th of the Philadelphia Section of the American Welding Society. In addition to motion pictures and slides illustrating this work, a number of metal-coated objects were exhibited to an interested audience of more than sixty-five. No further monthly meetings of the Philadelphia Section are scheduled until next September.

New Equipment

Hard-Surfacing Rods Available in Four Types

General Iron & Steel Co., 270 Lafayette St., New York City, exclusive distributors of Diamondite hard-surfacing rods for the United States and all foreign countries, have placed on the market four types of Diamondite rods.

Diamondite Rod No. 1 is a super-hard, tough, wear-resisting rod, for use where high resistance to shock and severe abrasive wear, as well as to fatigue and heat, is required. Its use is recommended for oil-well drills, dies and wearing parts of machinery in cement plants and mines, where toughness is required in addition to hard surface. Diamondite Rod No. 2 is especially adapted to hard-surfacing of manganese steel castings, such as dipper teeth, latch plates, dipper fronts, and sprockets on excavating machinery, crusher parts, conveying machinery, etc.

Diamondite Rod No. 3 is said to weld readily to carbon steel, chrome nickel, chrome moly, and other alloys, and will stand severe abrasive wear as well as shock. Diamondite Rod No. 4 will weld readily to manganese steel and other alloys, and while it will stand severe abrasive wear, it is not designed for shock or heavy impact. The No. 4 rod is largely used in the sand and coke industries where a scraping wear takes place but no heavy impact.

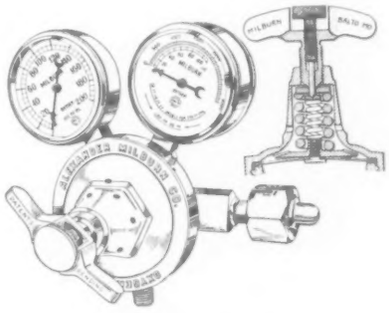
Diamondite hard-surfacing rods are available in sizes of 3/16 and ¼ in. diameter, and are packed in 5 and 10 lb. tube containers. Diamondite rods are claimed to weld readily to iron, boiler plate and all kinds of alloy steels, with either direct or alternating current welding or oxy-acetylene welding. The recommended use of these rods is described in a newly issued booklet.

Micrometer Adjustment Regulator

A regulator for use with oxygen, acetylene and other gases, which has a dual adjustment comprising a fine micrometer adjusting key housed within and operating separately from the main regulator key has been developed by The Alexander Milburn Co., of Baltimore, Md. The regulator has two compression springs, one within the other, operating a removable, non-corrosive metal diaphragm. The main key operates the standard or heavy spring, and the micrometer adjustment key a fine bronze spring which is said to enable the operator to secure a range of from zero to approximately 5 lb., in addition to the adjustment obtained with the standard adjustment key.

This means of adjustment is so fine that it is claimed that fractions of an ounce can be obtained with the micrometer key, either when the pressure is at zero or at whatever pressure the standard key has been set for on the regulator; for instance, if the key is screwed down until there is a pressure of 10 lb. the micrometer key adjusts fractions of an ounce up to 5 lb. more.

The regulator is extremely sensitive for the finer pressures necessary for low-pressure torches and small torches doing fine work and requiring close adjustment. It is valuable for torches working on aluminum, airplane parts, fine experimental work, lead burning, dental, jewelry and other delicate operations; also for laboratory and hospital work.



New Milburn Regulator.

The design of the micrometer key housed within the standard regulator key is strong, simple and effective and is so standardized as to be quickly applied to regulators the Milburn company has had on the market for a number of years. The only additions are a new key, button and bronze tension spring, when the regulator can be immediately converted with this improved feature.

Milburn standard regulators are made of solid bronze forgings, and have several new features. The inlet connections are removable and interchangeable so that the body of the regulator is suitable for any kind of gas, such as oxygen, acetylene, hydrogen, or for special tank or line connections, enabling the regulator to be immediately fitted with the connections desired, as well as the replacement of damaged connections without special tools or applying heat.

Long-Distance Control of Welding Heat

A special attachment consisting of an automatic control device with a control cable has been developed by the Welding Engineering Co., 2872 North 41st St., Milwaukee, Wis., for use with P&H Hansen arc welders. This device is easily attached and eliminates much time and inconvenience in changing the welding current in those locations where the welding operator is at a considerable distance from the welding machine or where it is inconvenient to get at the manual device on the machine for adjusting the current.

Using this remote control device, the welding operator carries along with him the end of the control wire to which is attached a small hand-operated circuit-closing device. Irrespective of where he is working, the operator keeps this device handy and by opening and closing the circuit he can change the welding heat to the desired amount. The proper control device can be selected by knowing the size of the P&H Hansen welder and its serial number.

New Spark-Resisting Cover Glass

A cover glass for use over the lenses in helmets and goggles to protect them against injury when welding, has been developed by the Cellucraft Co., 1709 W. Austin Ave., Chicago, Ill. This cover glass is sold under the name "Savuriz" and is said to be particularly resistant against damage by sparks. It is made in the standard 2x4⅛-in. size and also in a 2-in.-diameter size. Special shapes can also be provided.

Trade Literature

"Norite" electrodes for hard-surfacing are listed in a price sheet recently issued by the Stulz-Sickles Co., 134 Lafayette St., Newark, N. J.

"The Facts About Welded Piping for Buildings" is the title of a bulletin outlining the advantages of welded piping. Copies can be obtained from the Air Reduction Sales Co., 60 East 42nd St., New York, N. Y.

A portable ventilating unit, driven by a ¾-hp. gasoline engine, and designed for quickly and thoroughly ventilating confined working spaces, is described in

Bulletin 166, issued by the Coppus Engineering Corp., 344 Park Ave., Worcester, Mass.

"Universal" flux for the welding of aluminum and its alloys, cast iron, cast steel, copper, brass, and other metals is the subject of two pamphlets recently issued by A. S. Young & Co., 60/2, Bunhill Row, E. C. 1, London, England. Details are given on the welding of these metals in connection with the use of "Universal" flux.

Portable X-ray units for industrial work are illustrated in a folder issued by the Industrial X-Ray Corp., Chamber of Commerce Building, Los Angeles, Calif. The equipment described is known as the Philips "Metalix" X-ray apparatus.

Lotan solders and fluxes for welding, brazing and soldering ferrous and nonferrous metals and alloys, are listed and their applications described in a folder issued by the Lotan Division of the Robertson-Davis Co., 311 N. Desplaines St., Chicago, Ill.

"The Welding of Enduro Stainless Steels" is the title of a booklet issued by the Republic Steel Corp., Massillon, Ohio, and describing means of welding these steels by the arc, gas, and resistance methods. The effect of the welding heat on the weld and on the adjacent parent metal is discussed, chemical compositions and physical properties of the metals are given, and various applications are described.

The "Metallizing" process of metal spraying is the subject of a publication recently issued by the Metallizing Co. of America, 1218 Long Beach Ave., Los Angeles, Calif. The process is described, many applications are listed and illustrated, and a partial list is given of job shops using the process.

"Gasweld" carbonic-gas regulators are illustrated and described in a price list recently issued by the Gas Weld Equipment Co., 625 W. Jackson Blvd., Chicago, Ill.

The welding of manganese steel is the subject of a folder issued by the Manganese Steel Forge Co., Philadelphia, Pa., describing "Rol-Man" manganese steel welding rods and their application. Illustrations show work done with "Rol-Man" rods.

"A Handbook of Electric-Weld Tubing," describing the manufacture of tubing made from flat steel strip with the seam resistance welded, explaining the various types and finishes, listing data on physical properties, and giving standard sizes and tolerances, as well as other data, is available from Steel & Tubes, Inc., 223 East 131st St., Cleveland, Ohio.

News of the Industry

C. H. Hollup Joins Staff of Central Steel & Wire

The Central Steel & Wire Co. announces that C. H. Hollup has joined their organization. Mr. Hollup is very well known in the welding-wire field, not only as the founder of the present Hollup Corp., but also for the intensive research work he carried on with the Vilter Manufacturing Co. of Milwaukee, starting over a quarter of a century ago.

The Central Steel & Wire Co. is expanding quite materially both their welding-wire laboratories and manufacturing plant, to take care of the numerous new specifications they are bringing out and to make further developments.

Bryant Machinery Obtains Milwaukee Agent

Bryant Machinery & Engineering Co., 400 W. Madison St., Chicago, Ill., announces the appointment of James R. Murphy as exclusive representative in the Milwaukee territory with office headquarters at 610 W. Michigan St., Milwaukee. Mr. Murphy will handle the sales of all of the lines for which Bryant has responsibility as general distributor, including Swift resistance welders, Imperial arc welders, and many types of machine tools.

Kurfess Moves Up in Ryerson Organization

W. F. Kurfess has been appointed assistant vice-president of Joseph T. Ryerson & Son, Inc. M. J. Hartigan succeeds to Mr. Kurfess' former position as manager of the mill department of the company. Mr. Kurfess entered the structural-engineering department of the Ryerson company in 1912, and has become one of the most experienced and best posted merchandising executives in the steel business.

The Sprague Foundry & Manufacturing Co., Council Bluffs, Iowa, doing a general furnace-manufacturing, welding and machine-shop business, destroyed in a recent $80,000 blaze, partially covered by insurance, is to be rebuilt immediately, according to Julius Katleman, owner. The firm was the largest of its kind in this section of the state.

The Allsteel Press Co., 12015 S. Peoria St., Chicago, Ill., has appointed Leonard R. Nourie, Park Building, Pittsburgh, Pa., as exclusive representative in the Pittsburgh district for the company's line of presses and sheet-metal-working machinery.

"Whitey" Maurath, well known Cleveland manufacturer of special purpose electrodes, has moved his business to larger quarters at 7309 Union Ave.

The Buffalo, N. Y., district sales office of the Republic Steel Corp. has been moved to 475 Abbott Road, it is announced by N. J. Clarke, vice-president in charge of sales. No changes have been made in personnel.

Tools and welding equipment valued at several hundred dollars recently were stolen from the plant of the E. J. Voggenthaler Co., 376 E. Eighth St., Dubuque, Iowa. Thieves took their time and picked out the most valuable and easily transported equipment.

Floyd Turman, welding-shop operator, who until recently was located on American Ave. in Long Beach, Calif., has moved to Lynwood, where he is now doing business at 10112 Long Beach Blvd. Mr. Turman features aluminum welding, hard facing, and his specialty —starter-teeth welding.

A contract for rebuilding and reinforcing several highway bridges at Lincoln, Ill., has been awarded the Clinton Engineering Co., of Clinton, Iowa. An Aireo welding and cutting unit was purchased for this work.

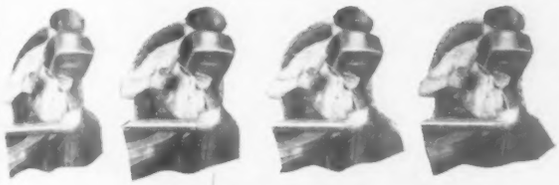
The name of the Kewanee Welding & Repair Co., Kewanee, Ill., has been changed to Kewanee Welding Co. and the partnership that existed between Don Stone and J. F. Reeves has been dissolved. J. F. Reeves is sole owner of the new firm, which will confine its activities to job welding.

A steel stack with an all-welded bonnet was recently completed by the Sam Baird Welding Works, Ottawa, Ill., for the Lockwood Glass Co. of that city.

Andrew Yates, who was connected with the metal industry in Peoria, Ill., for 30 years, passed away on May 25th, due to pneumonia.

Amos I. Drazy, Ashkum, Ill., has added an arc welder driven by a gasoline

for gas welding *and*



for electric welding

Thousands of satisfied users insist on Anaconda Rods

- *TOBIN BRONZE** (for gas welding) . . . the original low melting point bronze rod. Widely recognized as ideal for the general oxy-acetylene welding of cast and malleable iron. Saves time and money because of its low melting point—1625°F.
- *EVERDUR** (for gas or electric welding) is a patented alloy of copper, silicon and manganese and has excellent welding characteristics. Makes high-strength welds on copper, brass, bronze and copper-nickel alloys. Also used on thin sheet metal. Melts at 1866°F.
- *ANACONDA MANGANESE BRONZE* (for gas welding) produces a tough, strong bond, unusually resistant to wear. Especially adapted for building up surfaces subject to abrasion. Melts at 1598°F.
- *ANACONDA PHOSPHOR BRONZE* (for gas and electric welding) is extensively used for electrically welding copper, brass, bronze, wrought, malleable and cast iron, low and high carbon steels. Melts at 1922°F.
- *ANACONDA BRAZING METAL* (for gas welding) is a high-zinc brass for welding where strength is not essential. Melts at 1634°F.
- *ANACONDA ELECTROLYTIC COPPER* (for gas welding) is recommended for welding copper where high electrical conductivity is essential. Welds are quite ductile. Melts at 1981°F.
- *ANACONDA SILICON COPPER* (for gas or electric welding) is used to fabricate metal furniture and for other sheet metal work. Requires no flux. Has a good electrical conductivity and makes a strong, sound weld. Melts at 1981°F.

*Trade-marks "Tobin Bronze" and "Everdur" Reg. U. S. Pat. Off.

COPPER alloy welding rods . . . because of their strength and low melting points . . . are extensively used for welding iron, steel, copper and copper alloys by both the oxy-acetylene and carbon or metal electric arc methods. The consistently high quality of these Anaconda products explains their popularity with thousands of satisfied users who will accept no other brand of copper alloy welding rods.

Each of the seven different Anaconda Welding Rods listed at the left has its individual characteristics . . . and each is particularly adapted to certain types of work. Most widely used is Tobin Bronze* . . . because of its acceptance as the ideal rod for the general oxy-acetylene welding of cast or malleable iron. With Tobin Bronze, which melts at 1625° F., preheating is usually unnecessary.

All Anaconda Welding Rods are uniform in composition and high in quality, due to the experience and technical knowledge of The American Brass Company. All are available through leading distributors of welding supplies . . . usually shipped in bulk, but also obtainable in clearly labeled ten-pound packages. And all are described in Anaconda Publication B-13, mailed on request.

ANACONDA
from mine to consumer

THE AMERICAN BRASS COMPANY
General Offices: Waterbury, Connecticut
Offices and Agencies in Principal Cities
In Canada: ANACONDA AMERICAN BRASS LTD., NEW TORONTO, ONTARIO

ANACONDA WELDING RODS

motor and all mounted on a two-wheel trailer, to his shop equipment.

The Torchweld Equipment Co., 1035 W. Lake St., Chicago, Ill., has opened a New York office. Details will be announced at a later date.

The entire business and assets of the Audubon Wire Cloth Co., Inc., of Audubon, N. J., have been acquired by the Manganese Steel Forge Co., of Philadelphia, Pa., who will conduct the business under the name of the Audubon Wire Cloth Corp., a new organization.

The McLean Welderlite Co. has taken over the Beckwith Iron Works, 530-532 West 79th St., Chicago, Ill., including a 3-story building with 50-ft. frontage. The company will engage in the manufacture of welded products, production welding and hard facing of tools.

· CLASSIFIED ADS ·

Help Wanted—75c per line, minimum 4 lines. Jobs Wanted—4 lines free. Other Ads—$1.00 per line, minimum 4 lines. Count 8 words to line. Add 6 words for keyed address.

FOR SALE

For Sale—Arc Welders, gasoline or electric driven. Spot Welders. Overhauled. Guaranteed. Attractively priced. Dealer correspondence invited. Electric Power Motors, Inc., 1087 East 97th St., Cleveland, Ohio.

A Check or Order on Any Closed Bank will be accepted in exchange for full or down payment on welding apparatus, electrodes, or accessories. In other words, we believe every bank is coming back. Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J.

Standardized Cutting and Welding Tips, interchangeable with various types of torches; also apparatus, accessories and complete outfits. Prices unbelievably low. High quality and workmanship. Write for catalog. The Alexander Milburn Company selling on behalf of TIPS, INC., 1416-18 W. Baltimore St., Baltimore, Maryland.

BARGAINS—ARC WELDERS

Gasoline or electric drive. 30 days' trial. Terms if desired. Write Ken's Equipment Exchange, Box U 631, Troy, Ohio.

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WILL INCREASE YOUR EARNING POWER

by bringing you any one of the following guaranteed

FLUX FORMULAS

Cast Iron—Brazing—Copper—High-Speed Steel—Aluminum (good for both the cast and sheet metal)—or all for $4.00. With instructions YOU CAN MAKE YOUR OWN fluxes just as hundreds of the most successful welders are doing today who insist on having their fluxes fresh when they need them for the better job.

R. N. Robbins, 38 Winans St., East Orange, N. J.

POSITIONS WANTED

Combination Welder—17 years' experience with arc, gas, and thermit, in production work, marine work, and job shops. F. C. Korpus, 2954 Fortieth St., Chicago, Ill.

Trained Welder and Supervisor—16 years' experience in field erection of plate work, also time study and fabricating-shop work. Address Box 115, The Welding Engineer.

Cast Iron Welding Rods

The Decatur Casting Company
Decatur, Indiana

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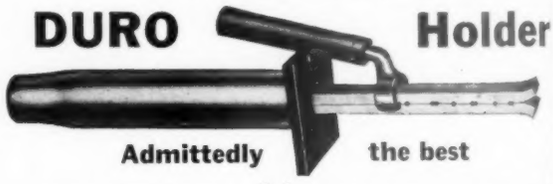

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Joke

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